SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; JOSEPH Le CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. McKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, MAY 11, 1900.

CONTENTS:

Report of the Watson Trustees on the Award of the Watson Medal to David Gill: PROFESSOR S. NEWCOMB 721
Experience Notes upon Plot Experiments: PROFESSOR BYRON D. HALSTED 726
Modern Problems in Acoustics: CHARLES K. WEAD 732
Opportunities for Biological Study in Paris and the Requirements for the New Doctorate: PROFESSOR FREDERICK C. NEWCOMBE 736
The Senses of Primitive Man 740
Oliver Payson Hubbard: PROFESSOR J. J. STEVENSON, DR. A. A. JULIEN 742
Scientific Books:—
Royce's—World and the Individual: PROFESSOR R. M. WENLEY. *A Preliminary Report on the Geology of Louisiana:* DR. W. H. DALL. *Loew on the Physiological Rôle of Mineral Nutrients:* PROFESSOR D. T. MACDOUGAL. *Wiechmann's Chemistry, its Evolution and Achievements.* PROFESSOR W. A. NOYES.
Books Received 743
Scientific Journals and Articles 747
Societies and Academies:—
Biological Society of Washington: F. A. LUCAS. *Section of Geology and Mineralogy of the New York Academy of Science:* DR. THEODORE G. WHITE. *The Academy of Science of St. Louis:* PROFESSOR WILLIAM TRELEASE. *American Mathematical Society:* PROFESSOR F. N. COLE. *The New York Section of the American Chemical Society:* DR. DURAND WOODMAN 749
Discussion and Correspondence:—
Physical Observations during the Total Solar Eclipse: A. LAWRENCE ROTCH. *The University of Cincinnati:* PROFESSOR THOMAS FRENCH, JR. *'00 or 1900:* PROFESSOR E. L. MARK 752
Current Notes on Physiography:—
The Mexican Boundary; Glaciation of Sierra Costa, Cal.; The Trough of Lake Nyassa: PROFESSOR W. M. DAVIS 753
The Making of a Museum: F. A. L. 755
Scientific Notes and News 756
University and Educational News 760

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

REPORT OF THE WATSON TRUSTEES ON THE AWARD OF THE WATSON MEDAL TO DAVID GILL.

AT the last annual meeting of the National Academy of Sciences the Watson medal was, on recommendation of the Trustees, awarded to Dr. David Gill, Her Majesty's Astronomer at the Cape of Good Hope, for his work in perfecting the application of the heliometer to astronomical measurements resulting in an important advance in astronomy of precision especially in the determination of the parallaxes of the sun and stars, and of the positions of the planets. In accordance with our custom I now have the honor to submit a fuller report on the work in question.

It is as true of the astronomer as of the poet that he must be born, not made. Although there is no branch of research in which a wider knowledge of the whole field of physical science and a broader grasp of first principles are necessary than in astronomy, it is none the less true that this knowledge and grasp must be supplemented by that indefinable quality born in the man which leads him to pursue astronomy with zeal and success. The career of our medalist offers a remarkable example of this fact. So far as can be inferred from his writings, his early training was rather in the direction of mathematical science, especially horology, than in that of astronomy. His first appearance as an active worker in

the latter science was in connection with the transit of Venus in 1874. He was at that time the coadjutor of Lord Lindsay, afterward Earl of Crawford and Balcarres, who was so much interested in astronomy that he had erected an observatory at his seat, Dunecht, near Aberdeen. Gill was placed in charge of the institution and the works done there were published in the joint names of the two.

When the transit of Venus of 1874 was approaching, a special private expedition for its observation was fitted out by Lindsay, with Gill as his leading assistant. Here the latter gave the first evidence of that tireless energy which has marked his whole career. Not satisfied with merely executing the work pertaining to the expedition, he organized, under Lindsay's direction, a campaign to determine a chain of telegraphic longitudes from Berlin to Malta, Alexandria, Suez and Aden. From here the chain extended to Bombay, in the east, and to the Seychelles, Reunion, Mauritius and Rodriguez in the south. Thus the expedition, in addition to the observations which were its main objects, made an important contribution to geodesy and geography.

It was in connection with the observations of the transit that he made his first application of the heliometer, an instrument which he has since done so much toward bringing to its present state of perfection. Although this instrument had been in use in Germany for nearly half a century, and was celebrated as that with which Bessel had first determined the parallax of a star, astronomers were not alive to its possibilities. Its application was greatly restricted by the imperfection of its construction and, although one had long been mounted at Oxford, little use was made of it in England. In fact its application was limited by a defect of its construction. The Repsolds of Hamburg introduced the important improvement of making the two divided halves of its object glass slide in a circle having its center at the focus, instead of moving in plain guides, as in the former construction. Its range was thus greatly widened and its accuracy increased.

With the instruments as thus improved Gill, in addition to the observations which were the main object of the expedition, made at Mauritius his first essay in the line which he has since followed with such success; the determination of the solar parallax by observations of the minor planets. The planet chosen for the purpose was Juno. The method was that of observations as far as possible to the east and west of the meridian, the parallatic effect being obtained by the motion of the observer as he was carried around by the earth's rotation, instead of by differences of direction from two distant stations. The result of the observations was 8″.77, which we now believe to be a nearer approach to the truth than was supposed at that time.

The success of this attempt led our medallist to inaugurate another on a larger scale in which he was himself the sole actor and mover. This was his celebrated expedition to the Island of Ascension in 1877, in order to determine the solar parallax by observations of Mars at its perihelion approach to the earth, which occurred in September of that year. The method was the same as at Mauritius, the instrument used being the heliometer, and the parallatic effect being obtained by the difference in the direction of the planet in the morning and in the evening. The result of the work was worked out with that thoroughness which is characteristic of the highest order of astronomical research. One of its most important features was a discussion of the personal error in the right ascension of faint stars depending on their magnitude, an error which had long been suspected, but had evaded all efforts to so determine it that it could be eliminated from the re-

sults. It is now well established that, in our traditional method of determining right ascensions by transits of stars over the threads of a meridian instrument, all observers, whatever method they adopt, note the transit of a faint star too late relatively to a bright one. The error varies with the observer and the conditions to such an extent that its amount almost defies exact determination. The problem of getting rid of it is among the most serious with which the astronomer has now to contend.

One circumstance will illustrate the extreme precision reached by Gill in this work. The final discussion of his observations brought out a seeming periodic change in the longitude of Mars, going through its period in about half a month. Theory afforded no explanation of such a change. Years afterwards it was traced to an error in the ephemeris of the planet, which had been prepared for him by an official authority, in which certain extremely minute terms of the nutation were not consistently applied. So minute an error would never have been detected by any other method of observation.

The result found for the solar parallax was 8″.78. The main source of doubt to which it is subject, apart from unavoidable accidental errors, arises from the possible uncertainty in bringing the image of a star into coincidence with the center of a planetary disc. The effect of phase and a possible difference of personal equation in estimating the center of the planet on the two sides of the meridian introduce a certain amount of doubt. At the same time there is some reason to believe that the value is as near the truth as any that we can get at the present time.

One result of this expedition is of more than astronomical interest. It gave rise to a very pleasant book by Mrs. Gill, 'Six Months in Ascension,' describing life on a far distant island within the tropics, as well as the work of the expedition.

In 1881 Gill was appointed Director of the Observatory at the Cape of Good Hope, succeeding Mr. E. J. Stone. Although under the capable direction of the latter this establishment had continued to add to its reputation as one of the few important observatories in the southern hemisphere, no one could have seen in it an inviting field for astronomical research generally. Its instruments were antiquated, its means in other respects extremely limited, and its staff insufficient to the execution of any important enterprise. The general impression might therefore have been that, while an astronomer of ability might be able to do some good work at the Cape Observatory on traditional lines, it would be impossible for him to enter upon a great career. But the new astronomer soon showed that his energies were not limited by his unfavorable surroundings. He had learned what could be done with the heliometer, and what further improvements could be made in it in order to bring it to the highest state of perfection. Then he found an inviting field for its application.

The question of the parallax of the fixed stars has long been, from a scientific point of view, one of the most important with which the astronomer has to deal. To determine this quantity is equivalent to determining the distances of the stars and hence making a step towards estimating the dimensions of the universe and the arrangement of its constituent bodies in space. Twenty years ago the parallaxes of a number of fixed stars had been measured, but, in the greater number of cases the difficulty of the problem was such that the results were open to more or less doubt. The new and perfected heliometer was the best instrument for deciding the question and, by using it in the southern hemisphere, it was applied to a field almost entirely uncultivated. It is gratifying to us to know that, in this work, he found an able col-

league in our fellow member, W. L. Elkin, who spent some time at the Cape Observatory, carrying on with Gill the work of the new instrument. It was one of the happy results of this co-operation that the Yale University was equipped with the finest heliometer that had then been made, and the instrument placed in the hands of Gill's co-worker. This is the only instrument of the kind that has yet been mounted on this side of the Atlantic.

The result of Gill's enterprise is that, at the present time, the parallaxes of perhaps a dozen stars of the southern celestial hemisphere have been determined with greater general precision than has been attained in the case of any corresponding number in the northern hemisphere. One conclusion from this work is of a nature to excite universal interest. The second brightest star in the heavens, Canopus, almost as bright as Sirius, has no measurable parallax. What must be the actual size and brilliancy of a star, which appearing to us as bright as Canopus is yet so enormously distant as to defy the most refined methods of determining its annual parallax? We can only answer with confidence that it is thousands of times the brightness of the sun. Whether we should say 20,000, 10,000 or 5000, no one can decide. What adds to the singularity of the result is that this case is by no means unique. Rigel and Spica, both of the first magnitude, are also beyond our range of measurement even with the most refined of instruments.

One prominent feature of the astronomy of our time is the initiation of international co-operative enterprises to carry on such of its researches as require to be conducted on a large scale. One of these enterprises was organized by our medallist. His experience in determining the solar parallax from observations of Mars and Juno led him to point out the advantages offered by near approaches of the minor planets generally to the earth for the determination in question.

In the course of a little more than a year, from the summer of 1889 to the autumn of the year following, there were to be three favorable approaches of these planets to the earth. An arrangement was made with the observatories of the world which had good heliometers in use, and were willing to engage in the work, to make the required observations. The labor involved in carrying out the whole plan in the best way was very great. The mere making of the observations was a simple matter compared with the subsequent reductions and investigations. The first step in the process was a determination, made with all possible precision, of the positions of the stars of comparison. Not only observers who used the heliometer, but all others who were willing to engage in the work took part in this branch of it. Then it was necessary to derive the best possible elements of motion of the three planets. The question how to discuss the observations so as to obtain results which should be as free as possible from the necessary errors in the elements was another important consideration.

The entire work appeared in 1897–98 as Vols. VI. and VII. of the Annals of the Cape Observatory. An examination of these magnificent volumes will give a better conception than anything that I can say of the amount of research devoted by Gill to this investigation. It is impossible within the limits of the present report to give even an abstract of their contents. We must therefore limit our notice to the general statement already made. It should, however, be mentioned in this connection that the discussion of the observations of one of the planets, Iris, was especially taken in charge by the collaborator whom I have already mentioned, Dr. Elkin.

The definitive results for the solar parallax from the three planets separately were:

From Victoria:	$8''.801 \pm 0''.006$
" Sappho:	$8''.798 \pm 0''.011$
" Iris:	$8''.812 \pm 0''.009$

the combined result from the three, stated in round numbers, is 8″.00. This value has since been adopted, I believe, in all the astronomical ephemerides. That it will stand the test of time is however too much to expect. The improvements now being made in the means and the methods of research will necessarily include the solar parallax in their scope. But no change that may thus be made in the accepted value will diminish our admiration of the skill, industry and perseverance which our medallist has spent upon his greatest work.

While the investigations which I have mentioned, especially the last, are those which the academy had in view in awarding its highest honor in the field of astronomy, there is a work of another class of the first order of importance which cannot be passed over in silence. I refer to the 'Photographic Durchmusterung' of the southern heavens, from 18° of south declension to the pole. The third and completing volume of this work has just appeared. It offers several features of general interest. One is the curious fact that, with its completion, we now have a better knowledge of the stars of the southern heavens, invisible in out latitudes, than we have of the northern. It is an act of simple justice to one of our own countrymen now pursuing his work in the Argentine Republic, to say that this disparity in our knowledge of the stars in the two hemispheres is being markedly increased by the survey of the southern heavens carried on by Dr. Thome at the Argentine National Observatory. The fact that Dr. Thome employs the visual method instead of photography adds to its value in the present connection.

This enterprise of Gill's is intimately associated with the great international enterprise of making a photographic chart of the heavens. In 1882 a great comet appeared, and Gill engaged a Cape Photographer to take its picture. He was interested and surprised to find that along with the comet were taken the surrounding stars down to the 9th magnitude. Evidently here was a method of making star maps which offered great advantages over the laborious process of dotting down stars from eye observation. He communicated his suggestion to Admiral Mouchez, Director of the Paris Observatory and the question was taken up experimentally by the Henrys. The result was the Paris Photographic Conference of 1887, which inaugurated the enterprise now, we hope, approaching its completion.

An interesting circumstance may well command our attention. The Cape Photographic Durchmusterung is the work of two men, whose co-operation offers a remarkable example of that disinterested devotion to the increase of knowledge which is so conspicuous a mark of all modern science. The mere taking of the photographs was not the whole work, it was not even its main portion. The position of the stars on the glass plates must be carefully measured one by one, and every star-image studied by itself, with the view to determine its magnitude. How was it possible to devote the necessary attention to 350,000 separate objects? The one to do it was found outside of all English connections in the person of Professor J. C. Kapteyn, of the University of Groningen, Holland. I know not how many years of patient toil, which would have made the fortune of a business man, was spent by Kapteyn in this work. What gives interest to it is that it is an almost unique example in the history of science of a man of the highest order of general scientific ability in one country de-

voting his time to what was formally an official work of the government of a foreign country.

This attempt to set forth in a few words the scope and significance of twenty-five years unremitting labor on the part of one who would have made his mettle felt in any sphere of activity he might have chosen to enter may well appear to others, as it does to us, extremely inadequate. The work of Gill may fairly be called epoch-making in a sense even better than that in which the term is commonly used. If we find in it no brilliant discovery to attract the attention of the public, it offers us what is yet better; improved instruments and methods of research applied with such tireless industry, conscientious care, sound judgment, and accurate knowledge of every related subject as not only to expand our intellectual horizon, but to supply the astronomer of the coming generation a pattern which he can study with profit to himself and advantage to his science.

S. Newcomb.

---

*EXPERIENCE NOTES UPON PLOT EXPERIMENTS.**

Field experiments are not easy to plan and very difficult in execution. Uncertainty attends every step from the soil to the seed —the cultivation to the harvesting of the crop.

During the past six years the writer has had two acres under experimentation, and no lesson has been more impressive than that of the lack of uniformity of the soil. An apparently even plot will vary in the composition and texture of the soil, almost from one foot to another. This may be due to many causes, not the least important being the rock strata, gravel beds, etc., that underlie the soil. The surface is usually far from level and the shaving down and filling in to bring the surface to a grade only emphasized the differences that already existed, as results upon the experiment grounds before mentioned abundantly prove.

The field itself should be laid off with exactness, and this means the aid of the surveyor or his instruments. The corner stakes should be set deeply and never removed, and those of each plot should be established once for all. Unless this is so the plots will move and the subdivisions will vary, and shortly the whole area is unsatisfactory, if not in confusion.

Ideal experiment grounds should have the same exposure. There are objections to perfectly flat land, and there are more to a rolling surface. The grounds under the charge of the writer are upon a slight incline, nearly uniform throughout the two acres; but even there a wash of the soil is always troublesome during heavy rains, and introduces an element of uncertainty when soil treatment obtains upon the plots.

There should be no tree, bush or other tall object upon or close to the trial grounds. The shade of a single tree may do more to disturb the course of an experiment with sun-loving crops than the sapping of the soil of plant food by the roots of the same tree.

This matter of the influence of shade has been tested by means of lath by the writer; it is very great, and incidentally it should play no part in the experiment grounds. It is not safe to grow corn or any like tall crop within many feet of any small crops, as lettuce or spinach. The scheme needs to be so planned that the question of shade is reduced to a minimum. This is one reason why the outside plants are not comparable with these in the interior of the plot.

A single back furrow or a dead furrow

* Presidential address before the Society for the Promotion of Agricultural Science, Columbus, Ohio, August 19th.

running through a plot will so change the capacity of the area as either to vitiate the results or render them exceedingly unsatisfactory. To avoid this and prevent the mixing of treated soil the writer has resorted to the spade.

He has experienced great difficulty in manuring the plots evenly. This is a practical difficulty, not appreciated by the average workman, and if the dung is drawn directly from the barnyard there may be a great variation according to the amount and character of the bedding used. The manure should be made by only one class of animals, as cattle or horses, or mixed with the greatest care. Instead of being spread upon the plots in winter it is better to place it in piles and when well rotted and forked add by weight or measure, preferably the latter, to the plots. With commercial fertilizers the above difficulty is eliminated.

During last winter a test was made of placing the piles of manure upon some of the plots for the purpose of determining the influence of the same upon the soil and crops. In every case the growth was much retarded and in some instances the seed did not produce more than a small fraction of the full quota of plants. The results of an experiment would have been worthless for any plot where a manure heap had been upon a portion of the ground.

It is not the purpose here to discuss the cause of the failure where the enriching was excessive, but the fact remains and any one who would follow plot experimentation must not fail to manure his land evenly with the greatest care and prohibit the piling of dung upon the plots.

Previous Crops.—One could have all the points in common save that of the previous crop and the results might be worthless. This the writer knows to his sorrow. The influence of a crop is more lasting than one might suppose. Of course the wide difference between sod ground and cultivated land goes without saying; but let both previous crops be tilled ones, as for example, beans and corn, or potatoes and onions and there is enough of the personal equation to make the land unsuited for plot experiments unless the plots are confined to some one crop. When a crop is successive no portion of that experiment should grow upon old land. The marked influence of any leguminous crop is a case in hand. The soil from an old pea, bean or clover field when added even in small quantities to land new to such crops may double the yield. Turnips after turnips may be so diseased as to neutralize results of cultural treatment when compared with the same crop upon new land.

All prospective ground for a plot experiment ought to be uniformly in the same crop or succession of crops for a term of at least five years and fallow for the last season.

That the quality of the seed has an influence upon the results goes without further saying. In the early days of the writer's experiments the supply of seed would sometimes fail and that of another lot, but of the same variety would be used to finish the area. With bush beans, for example, it is very difficult to get the same strain of a variety from different dealers. The same is true of potatoes and nearly all sorts of truck crops. It is of considerable importance, therefore to purchase so liberally that there is no chance of one plot not receiving from the same lot of seed as all the others.

As it is our practice to grow two and even three crops as of peas and beans, during a season, it is imperative that enough seed be purchased in the spring to supply the needs of all the sowings and plantings of the growing season.

In planting and sowing there is a possible element of variation. After the seed bed has been made as uniform as possible throughout the whole area, the sowing or

planting should be done by one man only and all upon the same day. One man may make the drills for the peas, turnips, beans or onions, but only one should do it for any given experiment. Another man may drop the seeds, but he should drop it all, unassisted by a second person anywhere. A third person may do the covering, but no one should help him. So important is this matter that it is the writer's plan to have the sowing or planting of a plot begun at such a time that it will be finished the same day. Some experiments have been ruined by beginning late one day and a shower at night prevents the finishing upon the next. He remembers well noting the untimely appearing of the beans upon one plot when a portion had been covered by one man and the remaining portion by another. Some will cover a little deeper than another and firm the soil excessively. There is in mind an instance where one row of onion seed was accidentally trodden upon and it soon became conspicuous for the good stand of vigorous plants. Another instance is with beans in which the writer was the guilty party. He was doing the covering, and at the call of the dinner bell, left a row and a half of the dropped seed to lie in the open row and exposed to the hot May sun. That row and a half was covered an hour later, and many others were planted in freshly-opened rows during the afternoon. When the young plants appeared two weeks or so later the row and a half made a very poor stand that was evident to every one who passed that way. The moisture of the open row was dried out and a highly heated and dried soil was placed upon the seeds instead of the cool moist soil of a freshly-opened row, and in this there seems to be the great difference in the plants. If I had not covered all the seed and knew it was all out of the same sack it would have been difficult to convince me that the cause was in the delay in covering the seed.

If it is so essential that the seed be covered by but one person through a whole plot, it goes without saying that plants should be set with even greater care. The writer has seen rows of cabbage, tomato and even strawberry plants that differed greatly from each other and the only point of variation was the person with the dibble.

Not more than one person is permitted to set the egg plants, for example, in an experiment plot at the New Jersey Experiment grounds. A second person may assist, but the ideal in all this work is when the same individual has brought the plants through all their vicissitudes of the seed bed, the potted plant and placed them in the field.

The Importance of Surplus.—There are so many contingencies that the experienced experimenter will have a large surplus in store in many ways. He should have some plots or portions of plots at hand in case land is needed at any time. There needs to be a surplus of any given seed for emergency. A crop may fail and a reseeding is advisable or the stand is so poor that a portion of the plot is made the basis of a new test, and the same old stock of seed is desired.

There should be a surplus of plants in the row so that they may be thinned to the desired distance after the chances are that there will be no further losses. Some unforeseen cut worm may take the corn or a bad smelling bug the squash vine and the need of surplus plants is evident.

Nowhere else does the old saying hold so strongly as in the plot experiment. "One for the cut worm, one for the crow; five to plant and three to grow." The writer has had too many plots prove failures from a lack of a stand of plants that might have been avoided by greater liberality of seed to let this point go by without more than a passing notice.

In the case of plants that are set out the rule is still more important. There should

be a stock of eggplant or tomato plants far in excess of the number to be set, that the selection may be made in such a way as to give a uniform stand, fulfilling the requirements of the experiment. Such plants should be raised from the seed by, or under the eye, of the experimenter that he may feel sure of the kind and character of his plants. One would scarcely trust to ordinary commercial plants for use in a plot experiment. The seed might be mixed at the outset and an over stimulus might make the plants unusually tender.

In cultivation and all those processes which find a place under the term 'care of crop' one cannot be too serious. By a little carelessness here an element may be introduced that will spoil all the previous work. It is as essential, for example, that the whole plot be treated alike in the cultivation as in the sowing or planting. It is a good rule to never cultivate one row or plant unless the watch, and the clouds as well, indicate that there will be time that day for the same treatment of all in the experiment. If a half of a plot is hoed one day and the job finished the next, there are substantial reasons for inferring that the harvest of results will be scattered and scarcely worth the gathering together. There is a chance in all this work of being faithless to the ideals of the genuine experimenter who is constantly striving to eliminate all but the one point of variation in the test. For example, the wheel cultivator may be used twice in the row for a half of the plot and only once for the remaining portion and, while saving time it is robbing the experiment of its full value. A person who could permit such a thing is entirely unfit to occupy, much less fill, a position in a center of research, which we call in this country an Experiment Station. Far better to clean up the paths in the late afternoon than to make a beginning only upon a plot with hoe or cultivator.

It seems almost unnecessary to add any remark here concerning the necessity of keeping experiment grounds clean of weeds until the time is past when they can interfere with the results. Each plant in the crop should have its full soil and air space, and if weeds are permitted to contend for these essentials, the test, whether it be of fertilizer or distance or depth or any other thing, fails. Pigweeds and purslain and the whole list of weeds must be kept out of a plot experiment, and all results should read between the lines—these are with clean culture always understood. This is the cheapest as well as the only way.

There is a watchfulness demanded by the superintendent of field experiments that savors of the wisdom of the owl. He must also love truth beyond all else. Pardon me if I mention one of the elements in plot experiments that has been a great source of annoyance. It is the end plants and the outside rows. There ought not to be any, but it is not easy to get rid of them.

Their terrors came to me very forcibly last year in the old plot of eggplants, where the end plants, that is the outside row, all around the plot, was vastly better than those within, and demanded a separate record; but it was not made. With beans, an extra row has sometimes been planted upon the outside and rejected in the final results.

This problem of the end of side row only emphasizes what has gone before, namely the importance of placing each and every plant under precisely the same conditions as all the others. This is not done in case of the end plants and the results may be considered accordingly.

Troubles not to be Avoided.—There are dangers which all crop plants run. Stray animals may break in and destroy. Pigeons may get the first sowing of peas before germination. Moles may burrow under a plot and introduce a source of error. The hole thus made will turn the flow of an ir-

rigating stream away from where it seems to go. The winds may blow down and destroy the branches and their fruit, and frosts sometimes bring an untimely end to a vigorous stand of plants. Thieves may break through and steal.

Weather we cannot control, but long-season crops should be started early. The enemies of the street need to be fenced out as securely as possible, but it is not easy to put a pad-lock upon a field experiment. Poison for the vermin, insecticides for the insects and fungicides for the diseases should be used with a judicious hand. One needs to guard his experiment area with infinitely more care than an ordinary orchard, farm or garden crop, for the fruits are an in-gathering of truth, as nearly as it can be obtained.

The Keeping of the Record.—This is the most difficult of all the operations connected with the successful issue of a field experiment. The conscientious superintendent will not trust to his memory for the details, nor write up the results from the information that is only in mind at the close of the experiment. He must keep a record of the stages of the crop from the time the ground is broken until the end of the harvest. This means during the more rapidly growing season the taking of almost daily notes as to growth of plants, etc., associated with rainfall and soil and air temperatures. The character of the notes will vary with the crop, but they, in any case, need to be full.

Many plans of note-taking have been devised, but of them all there is nothing better than a day-book for all the crops, from which the items are transferred upon rainy days and odd hours to the separate books for each particular crop. There is a journal, so to speak, for the beans, or each class of beans, as bush, dwarf lima and pole sorts, those of the peas, potatoes, tomatoes and cucumbers, etc. A set of small pigeon-holes placed upon the wall above the desk holds the crop-books close at hand. Note paper in pads has been tested, but the loose pages, while convenient for some things, are easily lost. Form-sheets with spaces for certain entries, and upon set dates with various schedules prove cumbersome, and from all the methods the writer has accepted the books as the most satisfactory.

Statement of Results.—The statement of results of plot experiments should of course be clear and comprehensive. The precise point to be held up to view will vary with the crop and the reason for the trial. In general it should be in percentage of increase, or of decrease, over the control plot where the single feature of the test did not obtain. For example, if the experiment is with a remedy for the pod spot of the beans the results admit of several methods of expression. They may be in terms of total weight of plants, of weight of marketable pods, or matured sound seed, or in percentage of diseases as compared with the control area. It seems to the writer that the chief point is the relative amount of marketable pods of the check plot. In other words, place in concise form the increase of the salable product, for this is the crucial test of the value of the fungicides. To this may be added the cost of the gain that the practicability of the spraying may be shown. As secondary matters the effect upon the whole plant and sundry other matters may be given.

But the end is not yet; to return to the increase of salable product. Shall it be shown in pounds or quarts or in number of pods. Snap beans are sold by the quart and it might seem the most natural method to state it in terms of quarts. In getting the results upon a plot it is easier to weigh the pods, and to assort out the spotted from the diseased pods it is simpler to count them. All these methods have been tested and experience suggests the counting as the

best method. It is less subject to error in the harvest, there is no difficulty with fractions, the unit is a natural one, and shows upon the face of the results that each pod has been inspected. Neither weight nor measure do full justice to the disease for the spotted pods average much smaller than the healthy ones. Finally from the numbers the percentages are made up and the gain or loss is instantly applied to whatever unit of quantity that is in vogue.

The results must be calculated to a full stand of plants for both the trial and check plots. The absurdity of anything otherwise is evident with such crops as tomatoes or eggplants, but it is equally rational with bush beans or turnips. Sow the seed thickly and thin the crop to a given distance in the row, say six inches; count the plants at harvest for each row and if there are any missing allow for them.

Let the following serve as an illustration: A plot of ground is limed at the rate of 300 bushels per acre for the club-root in turnips. The adjoining plot has everything in common excepting the lime. The plants stand six inches apart and those upon the limed land flourish to the harvest time. Those upon the check plot languish and die from week to week and at the time the record is made only one-third are to be found. The roots are pulled and weighed, the roots weighed separately, assorted into those with and those without club-root and each lot counted and weighed. From the counts the percentages are made up, while the weights also go on record. One large unclubbed root will outweigh a dozen clubbed ones and the unfairness of weights as a basis for the final per cents. is apparent.

With the writer the results of his field experiments square usually to the line of disease, and the number of units of the plant product is the one that best conforms to the requirement of the case. With vegetable fruits as cucumbers, tomatoes, peppers, eggplants, it is the fruit and whether it is marketable or diseased. Tests have been made with the fruits left upon the plants until a single harvest day, as with cucumbers. The results may then become very striking to the eye; but the writer thinks the better way is to pick at the same intervals as for market and keep the record in the book. The results of the spraying may here be perhaps better estimated by counting the healthy and the diseased leaves and getting the percentage from these. The gain in marketable product is also given.

In root crops the writer has not always followed the plan herein advocated. Thus with sweet potatoes the series of experiments for checking the soil rot, started out five years ago with the pound as the unit and the plan has not been changed. It is not as easy and probably is not as accurate, owing to the fact that diseased roots are on the average smaller than healthy ones, because they are diseased.

In like manner in estimating the scab upon the round potato very scabby potatoes kept in a glass jar for the purpose and taken as one hundred per cent., have served for estimating the amount of disease of each pile at harvest time regardless of size or number, the crop being recorded in total yield in pounds and percentage of scab. For example weight of tubers 75 pounds, per cent. of scab 60; weight 84 pounds, percentage of scab 15.

The value of pictures is not to be overlooked as when the relative yields are placed in baskets, boxes or heaps. The superiority of the one treatment, whether of fertilizer, culture, pruning or spraying over another, in this way appeals to the eye in a vivid manner. Squares or circles upon the printed page will aid in the same way. There is, taken all in all, perhaps no better method of indicating the relative results than by the parallel bars, and they admit of many features in very small space. Thus three or

more grades of product may be shown by different shadings or the relative amount of healthy and diseased fruit or vegetable. Like all similar devices, they admit of errors of statement and need to be constructed with great care and then should always form an adjunct of the text.

The personal equation needs to be reduced to the lowest terms and the experimenter should test this at frequent intervals by calling to his aid the judgment of the disinterested person, who is competent to arbitrate. A person with his eye fixed upon some point to be reached may be oblivious to side lights that play an important part.

The born experimenter we may expect in the next generation, but the present station workers needed to be made and that quite quickly. When the ideal truth searcher comes we shall be shown how best to work for the truth, the whole truth, and nothing but the truth.

Byron D. Halsted.
College Experiment Station,
New Brunswick, N. J.

---

*MODERN PROBLEMS IN ACOUSTICS.**

The subject of acoustics appeals in one or more of its phases to a wide range of people:

To the mathematician, for the laws of vibrating bodies furnish countless problems that tax his science to the uttermost;

To the physicist, to whom primarily the field belongs;

To the architect, whose business it is to design auditoriums fitted for hearers as well as for spectators;

To the anatomist and physiologist, who finds in the organ of hearing a wonderfully complex structure that is incomprehensible without the aid of acoustical principles;

To the psychologist, who investigates the operations of the mind concerned in the hearing of sound;

To the instrument-maker, who must furnish the musician the means of expression and help him develop them;

To the musician, who cares to know the historical development and the foundations of his present art;

To the ethnologist, who recognizes music as one of the most important expressions of the life of a people; and lastly,

To all intelligent men who find with the Roman 'nothing of human interest alien to them,' and realize that a subject of such world-wide, time-long, interest as music may be studied profitably even by those who are not numbered among musical performers. For they appreciate the fact that here, as everywhere, the ability to learn *why* the alien does what he does, to enter sympathetically into his thought and see through his eyes, is the subtle power which distinguishes culture from mere knowledge.

In accordance with the custom of these Reports we are to take a bird's-eye view of recent progress in the science of acoustics.

I. In the history of acoustics two names are pre-eminent: Chladni, the text-book writer, who united to wide knowledge of the subject great ingenuity and experimental skill; and Helmholtz in whom there was a unique combination of mathematician, physiologist, physical experimenter and musician. His *Sensations of Tone as a Physical Basis for Music* published (in German) in 1863, and his monographs summed up in it, contained enough in each of these four lines to make one famous. The book has for nearly forty years dominated the thoughts of most people who believe that the science of acoustics has anything to teach musicians. Still it is significant that musicians have largely refused to recognize its sway, some showing crass ignorance in their comments, others making it clear that there is something in

* A Report from the Committee on Physical Science presented to the Washington Philosophical Society by Charles K. Wead.

the appeal of music to the human mind and heart that eluded his philosophy.

Though this ancient question of the physical basis of music is still a problem, there is time here to note but two points, and these have reference rather to the mode of attack than to the problem itself: (1) What scholarly musicians of to-day think of as music differs to an important extent from what was in Helmholtz's mind forty years ago as truly, though not as widely, as it differs from mediæval music; (2) Materials available in recent years for the historical study of European and Oriental scales disclose several consciously-used principles of scale-building which could not result in the diatonic or harmonic scales for which Helmholtz's overtone and resultant-tone theory furnished so strong a justification. Perhaps the greatest value of the book has been its stimulus to investigation in many fields, especially in the psychology of music; yet in spite of all our modern progress the greater part of the work remains as indispensable as ever.

II. Since the publication of Hemholtz's work the most noteworthy things in connection with Acoustics have been:

1. The multiplying and perfecting of methods and instruments, especially by König and Appunn; the development of the phonograph; the application of photography.

2. The publication of Rayleigh's mathematical *Theory of Sound;* of the ten volumes of the *Vierteljahrsschrift für Musikwissenschaft*, full of scholarly monographs on the musical and historical side; and of Ellis & Hopkins' researches on musical scales.

3. The developments in musical instruments (especially the piano), so giving us instruments of more accurate intonation and of greater power, and unfortunately driving out the older soft-toned instruments.

4. The general introduction into the household of the piano or reed organ, often leading psychologically to the conviction that there can be no music without harmony.

5. The building-up of several great collections of musical instruments from various lands and times, and the publication of books and monographs based thereon.

6. The accumulation of a vast amount of observations and experiments in the field of music-psychology.

III. Confining our attention now to Physical Acoustics, we may consider a little more in detail some of the recent advances that can readily be grouped together.

The *Velocity of Sound* in free air has been shown to increase greatly for very intense sounds, and has been measured in air compressed up to 100 atmospheres; the velocity in air confined in tubes is found to be a function of the diameter and nature of the walls, and of the pitch. The velocity in solids has been much studied, and measured even in such soft bodies as paraffin and rubber.

The *Frequency of Vibration* in specially favorable cases is now measured to within a few parts in a million; so the writing tuning-fork is now the usual means of dividing a second, say into 100 parts; but in ordinary cases, especially where the pitch is high, or the sound weak or of short duration, errors of some per cent. are frequent. Quite recently the sets of high forks made by Appunn for physiologists have been found to be extravagantly in error; but as partial compensation for the disappointment the science has been enriched by new experimental methods.

Of extreme importance to the modern physicist is the question of the energy involved in any movement. The experimental study of *Intensity of Vibration* began, I believe, with Töpler and Boltzman's ingenious optical determination, in 1870, of the actual variations in density in the air of a sounding organ pipe, and the distance

at which it could be heard, and so the energy per second required at the limit of hearing. More recently a Swedish experimenter found, by periodically thrusting a thermopile, mounted on a tuning-fork prong, into a sounding pipe at the node, a rise of 0.1° C., due to the adiabatic compression. Since 1870 experiments on the energy of organ pipes, etc., have been multiplied and refined. Similarly, determinations on the intensity of telephone currents and the movement of its disc have testified to the incredible sensitiveness of the ear. An amplitude of vibration of air particles of only one fifteen millionth of a millimeter in the region of 440 d. v. produces sensation.

Other investigations have traced the expenditure of the energy once stored in a vibrating mass; so the rate of damping of forks under various conditions has been observed; also the dissipation of energy in a resonator and the decay of sound in free air: it has been noted that a sound reflected repeatedly through a tunnel changes in quality, owing to the more rapid absorption of the overtones of high pitch. A contrary analytical effect is observed in some cases of echoes, as from a forest, where the sound of the voice seemed to come back raised an octave.

The relative absorbing power of various fabrics has lately been measured by Sabine. From his data I calculate that for a note of 256 dv. 0.33 of the energy falling on a sheet of hair felt one-half inch thick is absorbed.

A few instruments have been devised to produce a tone of definite reproducible intensity, and other instruments to indicate or measure the intensity of vibration at a given point. In Wien's beautiful manometer the minute yielding of a part of the wall of a resonator is measured by mirror and scale to one five hundredth part of its maximum amount, while the absolute value of the scale readings is determined to within a few per cent.

The study of *Form of Vibration* or *Quality of Sound* has been prosecuted both synthetically and analytically. König many years ago challenged Helmholtz's conclusion that the quality of sound depended only on the strength of the overtones, not on their relative phase; and he invented his wave-siren to prove his position. In this instrument the flow of air through several slits is carved into waves by several rotating discs, whose edges are cut into harmonic curves. More recently he has greatly perfected it, and attempted to meet various criticisms made against his earlier work; but so many lines of argument support Helmholtz's view, that I do not think this brilliant attack will generally be admitted to have conquered the field. A more reliable means of synthesis than the wave-discs is found in Appunn's sets of organ pipes; these furnish a great number of harmonics of one fundamental, and for each harmonic there are two pipes, a weak-toned and a strong-toned one.

Analytically the problem of form of vibration has been attacked in various ways, especially by photography. If the vibration to be examined is in the air either the König's flames connected to a set of resonators may be photographed, or a little mirror on a convenient speaking tube may throw a spot of light on the sensitive plate. If the sounding body is a wire, it is mounted to vibrate before a transverse slit through which light falls on the sensitive surface moving parallel to the string. Compound curves produced in either way are then subjected to harmonic analysis. In passing it may be noted that Mach obtained a photograph of a sound wave in air as far back as 1888.

The superposition of two vibrations has been further studied with reference to the pitch actually observed when two notes are beating; the old theory of combination tones has been rudely shaken and their objective existence proved experimentally in

certain rare cases. Mechanical superposition of harmonic motions has been obtained by many elaborate forms of harmonographs or curve tracers.

Both physicists and physiologists have devoted much attention to the study of the complex curves due to vowels and speech-sounds, working especially by aid of the phonograph.

Two or three matters of industrial as well as of scientific importance may also be noted, viz, the enormous development of speaking instruments—phonograph, graphophone, gramophone; the adoption by the Piano Makers' Association of the U. S. of the French standard tuning-fork giving A = 435 d. v.; and many improvements in organ pipes and reed stops that show a practical control over the wind sheet such as the older builders had not obtained.

IV. And now what are some of the most important *problems remaining to be solved?*

1. In pure physics: The simplification of the means for the precise determination of pitch in the ordinary practical cases; the establishment of convenient standards of intensity, and the perfecting of experimental means of measuring intensities; the development of means for the thorough analysis of sounds.

2. In connection with instruments: The thorough study of the action of the sounding board of a piano; of reeds as actually used in common instruments, and of the laws of the perforated tube as applied in flutes, etc.; the determination of the quality of tone produced by our common instruments under the conditions occurring in practice. Some day it will be possible to make as thorough and scientific an examination of a musical instrument as it now is of a steam plant or a dynamo. On all the points just noted current statements are inadequate, for the art is now so developed that the knowledge of the laws of vibrating bodies to the first approximation only is insufficient for future guidance.

3. In connection with architecture: the determination of the reflection or absorption coefficient of the various materials used in building for inside walls, with the numerical evaluation of the several factors that influence the acoustic properties of an auditorium; and the acoustic survey of auditoriums, showing the intensity of sound at all points where hearers might be placed.

4. In connection with practical life, the physicist finds the important problem of fog signals still unsolved.

5. On the side of psychology and music there may be named the further study of the capabilities and deficiencies of the human ear; the influence of instruments on musical conceptions; the historical, psychological and practical nature of the scales in use among various peoples; these branches bring our material study into intimate relations with human development.

V. In view of the manifold interests that center in the subject of acoustics, scientific and commercial, æsthetic and utilitarian, specific and general, it seems strange that neither by endowment in connection with a University, nor by government appropriation has provision been made for a well-equipped acoustical laboratory; for here the same reasons apply that justify similar expenditures for so many other branches of science, viz, that the subject is of large importance, either industrially or in its relation to past and present human activities; that the results of investigation would be of value to the community at large, being far wider than could be monopolized by the investigators; that the necessary expenses are beyond the means of the individual experimenter; and that nowhere in this country or the world is there any systematic exploiting of this field.

CHARLES K. WEAD.

OPPORTUNITIES FOR BIOLOGICAL STUDY IN PARIS AND THE REQUIREMENTS FOR THE NEW DOCTORATE.

It is not probable that many Americans, going to France for study in science, will think of locating elsewhere than in Paris. For while there are fourteen French universities outside of Paris, most of them well equipped for scientific work and holding the names of eminent men in their faculties, yet Paris with her numerous scientific institutions, with her unsurpassed facilities for research, with her array of famous biologists, shines with a refulgence which draws the eyes from the rest of France. But the scientific life of Paris is not and ought not to be the only attraction for the student seeking foreign study. The stores of art, the libraries, the historical associations, the political heart of the French Republic are all attractive to the enquiring American, and should each leave its impress upon him.

A very brief description of the institutions in Paris offering opportunites for biological study will indicate to some degree the extent of the field, which is as free to foreigners as to native Frenchmen. These institutions are five in number: the University, the College of France, the Museum of Natural History, the Pasteur Institute, the School for Higher Studies. All of these with the exception of the Pasteur Institute are to a greater or less extent controlled and supported by the Goverment.

I. THE UNIVERSITY OF PARIS.

The school of letters and of pure science of the University is denominated the Sorbonne. The buildings of the Sorbonne have been reconstructed and greatly extended during the past decade, so that the new Sorbonne is now composed of an immense collection of beautiful auditoriums and laboratories, all in a compact but well-lighted mass, located in the heart of the city, in the midst of the famous Latin Quarter. The laboratories are well appointed, displaying the usual equipment of modern institutions of a like nature. Students here, as in other countries, receive the attention of the director of the laboratory, and the aid of a corps of subordinates. In botany, the professors are Bonnier and Daguillon; in zoology, Lacaze-Duthiers, Delage, and Perrier; in physiology, Dastre.

Besides the Sorbonne, there are two institutes belonging to the University, primarily professional, but doing a considerable amount of purely scientific work. These are the Medical School and the Pharmacy School. The former has its buildings five minutes' walk to the north of the Sorbonne. Among the famous names in its faculty may be mentioned that of the physiologist Langlois.

The School of Pharmacy is nearly a mile to the south of the Sorbonne, occupies a beautiful site on the Avenue de l'Observatoire, and has fine buildings and a flourishing botanic garden of about one acre in extent in the court of the quadrangle. The school is attended by over 1700 students, this number being nearly equal to the number of students in letters at the Sorbonne, and also equal to the number in pure science. The professor of botany at the School of Pharmacy is Guignard, well known to American students for his contributions to vegetable cytology.

Should the student desire to pursue his study of biology during the summer, he may follow Bonnier to Fontainebleau or resort under other professors to one of the marine stations.

II. THE COLLEGE OF FRANCE.

In a square adjoining the Sorbonne is the Collège de France, with an organization independent of the University, yet working in harmony with it. This institution has its own lecture rooms, laboratories, and

faculties, and its professors are equally famous with those of the University. Botany is not included in the curriculum of the College, but in zoology there are Balbiani and Ranvier, and in experimental psychology, Ribot.

III. THE MUSEUM OF NATURAL HISTORY.

To the biologist, of perhaps greater interest than the Sorbonne, or the Collège de France, is the so-called Museum of Natural History. It is probably unnecessary to say that this noted institution is a great inclosure of approximately seventy acres, containing auditoriums, laboratories, museums, a zoological garden, and a botanic garden. The enclosure is more commonly known as the Jardin des Plantes. It is located on the south bank of the Seine, only ten minutes' walk from Notre-Dame. This spot is consecrated by the memories of such great men as Buffon, Jussieu, Lamarck, De Candolle, Cuvier and Milne-Edwards père. Its laboratories are to-day well directed by Van Tieghem, Bureau, Bornet, Deherain, and Maquenne in botany, by Milne-Edwards fils, Vaillant, Bouvier, and Perrier in zoology, and by Gréhant in general physiology. Besides the three subjects just named, the Jardin does work also in anthropology, geology and mineralogy. The roll of the scientific staff bears twenty names.

The opportunities for biological study here are unsurpassed. It is true that both the zoological and the botanical gardens come to have a shabby aspect in a dry summer, and suffer for lack of water, and the plants in the glass-houses are so crowded that they are unhealthy from insufficient light. But the living plants and animals are so numerous and accessible, the museums are so extensive, the laboratories are so adequate, and the library so full, that an investigator may be assured of all that equipment can supply. The museums of zoology and of comparative anatomy are probably the best in existence. The mounting and the grouping of the objects are elegant and effective.

IV. THE PASTEUR INSTITUTE.

The Institut Pasteur is located a mile or more to the west of the Sorbonne. In the present Institute, Pasteur did not live long to enjoy his enlarged quarters. His famous discoveries were made in a little building still standing in Rue d'Ulm near the Panthéon. In 1888 the present laboratory was opened, but Pasteur died in 1895. His tomb rests in a crypt beneath the building. The present Institute has already proved itself too small, and there is now nearing completion across the street an annex, larger than the present laboratory, and costing $400,000. This Institute is preëminently for investigation in bacteriology, fermentation, and biological chemistry, and for the preparation of serum for the prevention of disease. One will find in this great Institute excellent provision for research, yet not great complexity of means. Here work Duclaux, Roux, Chamberland, and Metchnikoff, names well known to biologists.

V. THE SCHOOL FOR HIGHER STUDIES.

The École Pratique des Hautes-Études is *sui generis*. This institution has no buildings of its own, but designates noted men anywhere in Paris, and in some marine laboratories, as members of its faculty. All its work is that of the seminar and the laboratory. Some of its professors are men with private laboratories, while some receive students in their own homes. The work of this institution is gratuitous to the student, and no degrees are conferred. The organization attempts to make available for research all the public and private resources of the great city. For its work in biology, it designates as its professors, the professors in the University, in the

Collège de France, in the Museum of Natural History, and in the Pasteur Institute. Admission to work is a matter of agreement between professor and pupil, the latter having to demonstrate his competency to the professor.

The foregoing brief account may suffice to show that the scientific institutions of Paris in equipment of laboratories and in facilities for research are the equal of those of any nation, and what is still more important than equipment, that the foremost scientists of France are professors in these institutions.*

ADMISSION TO RESEARCH. THE DOCTORATE OF THE UNIVERSITY.

A student is admitted to lectures in the University with no more requirement than the presentation of an admission card which is obtained gratuitously on application. Savants, French and foreign, may be admitted free to work in laboratories, on the recommendation of the dean or director or professors.

The ordinary investigator or student who is not a candidate for a degree, must present his certificates from the institutions where he has studied; and if these are acceptable, he must then matriculate with an annual fee of 20 francs. Besides this, he must pay an annual library fee of 20 francs, and a quarterly fee of 22.50 francs for each biological laboratory in which he works.

The laboratory investigator, not a candidate for a degree, will therefore pay annually in fees to the University 26 dollars.

In 1898, the French Government gave the French universities permission to establish a new degree—the university doctorate. This degree corresponds with the German and American doctorate. It differs from the usual French doctorate in that the latter requires longer to obtain and confers various privileges. The new university doctorate confers no privileges.

To enter upon a candidacy for a university doctorate in the University of Paris, one must present certificates showing his attainments. Graduates of good American colleges will generally find their credentials sufficient. The petitioner having been accepted, inscribes his name in the register, pays an annual library fee of 20 francs, a quarterly inscription fee of 20 francs, and a quarterly fee of 22.50 francs, for each laboratory in which he works.

If the foreigner enters on a scholastic level with the graduate *lycée*, *i. e.*, on a level with the French bachelor, he must complete two *superior studies* and a thesis. The superior studies correspond to minors, and may be selected from seventeen departments of learning. The minimum time for these two minors and the thesis is two years. But the candidate who can present and pass examinations in equivalents to these two superior studies may have the time of residence required for the doctorate reduced to one year. The candidate must present a thesis embodying original research, must defend this thesis before an assembly of professors, and must answer questions on other subjects proposed by the examiners. The examination fee in pure science is $60; in medicine, $135; in pharmacy, $186. The candidate must print his thesis, and furnish the University with 150 copies. The total fees, besides the cost of printing the thesis, will be therefore about $100 if the student

* A considerable amount of information concerning the subject discussed in this paper may be obtained from two pamphlets recently issued. The first is the *Guide illustré de l'étudiant etranger à Paris*, to be obtained from any bookdealer of Paris for 1 franc, 50 cent. The second is *The Universities of France*, published by the Franco-American Committee, to be obtained from Professor Michel Bréal, 70 Rue d'Assas, Paris. Professor Bréal is also prepared to answer any inquiries relating to study in France.

Some of the information contained in the last named pamphlet can be found in the Report of the U. S. Commissioner of Education for 1897-98, Vol. I., p. 749.

takes one year and about $150 if he takes two years in preparation for the doctorate. In comparison with this, one pays in science about $70 for one year and $120 for two years at the University of Leipzig.

Especial mention should be made of the fact that a student may pursue his work for the doctorate, not only at the Sorbonne, but instead at the School of Pharmacy, at the Jardin des Plantes, at the Collège de France, at the Pasteur Institute, or under the auspices of the École pratique des Hautes Études. That is to say, all these great and independent institutions are affiliated with the University, so that the University gives credit for their work. Thus a man who wishes to make his major with Bonnier at the Sorbonne, or with Van Tieghem at the Jardin des Plantes, or with Guignard at the Ecole de Pharmacie, or with Duclaux at the Institut Pasteur will find these various routes to the doctorate equally open. In all of these institutions the lectures are wholly free and gratuitous. In each of them, except in the Institut Pasteur, the fees of any one laboratory for a year are less than $20 dollars. In the Institut Pasteur the fee is $10 per month.

One is safe in saying that in no other city in the world can be found such a brilliant array of professors and laboratories. Truly France has shown a spirit of liberality toward educational matters unsurpassed by any country.

When, however, one studies the register of the University of Paris, one is struck with amazement at the smallness of the number of names of foreign students, especially with the smallness of the number of Anglo-Saxons. In the year 1897–98, the total registration of the University was over 14,000. The total number of Americans present was 44. Of these 44, 28 were in the college of letters, and hence we may assume that the most of them were in the University for the study of the French language. There were only 6 Americans studying pure science, 6 studying medicine, and one studying pharmacy.

The University of Paris contains, it is safe to say, nearly all the Americans who are studying in the universities of France. But compare the number of Americans who are studying in German universities and technical schools. The report of the U. S. Commissioner of Education for 1897–98 shows a registered attendance of 514, and estimates the total number as being over 1000. The registered Americans in Austrian institutions numbered at that time 106; and in Swiss institutions 65. In the year 1895, the University of Berlin had 4018 matriculates, of whom 159 were Americans; Leipzig 2798, of whom 53 were Americans; and Göttingen 878, of whom 30 were Americans. In the same year, Paris, with an enrollment of 10,951, had only 32 Americans.

Moreover the number of Americans in the University of Paris seems not to be on the increase, though the total number of students there is constantly rising. Thus in 1891, there were 45 Americans there; in 1896, 38; in 1897, 51; and in 1898, a recession to 44.

Naturally one pauses to enquire why Americans are so loth to choose Paris as their place of study. It cannot be due to the expense of living; for Paris is scarcely more expensive than Berlin or Munich. It cannot be due to the university fees; for, though for laboratory work and for the diploma, the expense may be somewhat greater in Paris, the expenses for lectures in Paris are nothing, and hence for the student in studies other than natural science, the university fees are lower at Paris than in Germany. The discrimination against Paris cannot for the most part be due to the previously existing requirements for the doctorate; for not half the Americans who go abroad for study seek the doctorate.

It is probable that the most potent influence turning the tide toward Germany rather than toward France, at least for the sciences, is to be found in the attitude of the American professors themselves, in the advice they give their students. This, however, cannot be held as an ultimate explanation.* Why do these men in American universities advise their students to go to Germany? Why are the scientific libraries in this country so much better stocked with German literature than with French literature? I cannot help the feeling, though I have no statistics, that on the whole Germany has, within the past forty years, produced more scientific men and more scientific literature than has France. It is doubtless true that we neglect unduly French scientific literature in this country. But it is probably also true that to-day, as forty years ago, we justly look to Germany as the seat of the leading spirits in the progress of biological science.

As a second reason cited by some to account for the lack of American interest in French universities, is the apparent distance placed by the French professor between himself and his students.

Finally we have the possible barrier of the difference in race, with all that this implies. Science is supposed to know no racial boundaries; but even scientific men are influenced by the hereditary and acquired ideas and ideals of their race.

Frederick C. Newcombe.

Ann Arbor, April 14, 1900.

THE SENSES OF PRIMITIVE MAN.†

There is a general belief that savages are able to see things that are invisible to the European, and the question is how far this alleged superiority is due to power of observation or to actual acuteness of vision. For the elucidation of this and many other problems in experimental psychology exact investigation is necessary on savages under natural conditions. This Dr. Rivers was enabled to do during the recent expedition to Torres Straits and New Guinea, which was organized by Dr. A. C. Haddon. Although the Torres Straits islanders are not now savages, they may fairly be described as primitive since a generation ago they were naked savages. The greatest amount of work was done on Murray Island, and the people readily allowed themselves to be experimented upon. The conditions were, as a whole, very favorable, the great majority of the natives investigated did their best as is evidenced by the smallness of the mean variation in most of the quantitative investigations. The Murray islanders are dolichocephalic Papuans with a very dark skin and the typical black frizzly hair. They also have the characteristic excitable Papuan temperament.

The visual acuity of these people was found to be superior to that of normal Europeans, though not in any very marked degree. The visual powers of savages, which have excited the admiration of travellers, may be held to depend on the faculty of observation; starting with somewhat superior acuteness of vision by long attention to minute details coupled with familiarity with their surroundings, they become able to recognize things in a manner that at first sight seems quite wonderful. But such exclusive attention as they have learned to pay to objects of sense appears a distinct hinderance to the development of the higher faculties. This view might at first seem paradoxical, since sense impressions are the foundation of the intellectual processes; but, on the other hand, the intellectual superstructure must suffer if too much

* As bearing on this topic, see 'Notes on the History of Foreign Influence upon Education in the United States,' by Hinsdale. Report U. S. Commissioner of Education, 1897-98. Vol. I., p. 591.

† Abstract of three lectures delivered by Dr. W. H. R. Rivers, before the Royal Institution of Great Britain, London, on Jan. 18, 25, and Feb. 1.

energy is expended on the sensory side. In the same way the savages lack of æsthetic appreciation of scenery may be accounted for, since distinctness of detail seems sometimes antagonistic to æsthetic enjoyment. The commonest defect of eyesight among Europeans is myopia, but this was found to be almost completely absent among savages. The opposite condition, hyperopia, which is apparently the normal condition of the European child, was very common among them, and, as it involved accommodation for distant vision, it is possible that the apparent visual acuity of the savage had something to do with a power of quicker and more exact accommodation acquired by constant practice. Some observations were made on vision at low luminosities, and while these were not altogether satisfactory they seemed to indicate that the natives of Torres Straits were able more quickly to adjust their eyes for darkness after light, and to see better in the dark than Europeans. Their binocular vision was normal.

An investigation of the color sense is important in studying the relation between language and ideas. There is a marked paucity in the color vocabulary in the Homeric poems and other ancient writings, Gladstone, and later Geiger, argued from this that there was an actual deficiency in color sense among the ancients and that an evolution in color sense has taken place within historical times. Dr. Rivers has carefully studied the color nomenclature of various races. The simplest he found was among some North Queensland natives, a number of whom had only three color terms. The next simplest was at Kiwai Island, at the mouth of the Fly River, British New Guinea, where there was no name 'for blue apart from black.' The two Torres Straits languages, Murray Island and Mabuiag, were more extensive. In these four vocabularies four stages may be seen in the evolution of color languages exactly as deducted by Geiger, red being the most definite, and the colors at the other end of a spectrum the least so. It was noteworthy, too, that the order of these people in respect to culture was the same as in regard to development of words for colors. The Eskimo, Dr. Rivers observed, differed radically from the languages of the tropical peoples he had examined in possessing an extremely well developed color vocabulary. The epithets used for colors in Homer were discussed and the conclusion was arrived at that the features of his color language were essentially of the same nature as those found among primitive peoples of the present day.

Speaking of the objective examination of color sense in Torres Straits, Dr. Rivers said the people show no confusion between red and green, but they did between blue and green. The investigation of their color names, he thought, showed that to them blue must be a duller and darker color than it was to us, and indeed the tintometer had afforded evidence of a distinct quantitative deficiency in their perception of blue, though the results were far from proving blindness to blue. Dr. River's then discussed some of the objections that had been urged against the theory of an historical evolution of color sense, coming to the the conclusion that it was not to be lightly put aside, though it could not be regarded as fully demonstrated. Next he considered some of the factors that determine the special characteristics of primitive color language, giving some instances, from widely separated parts of the world, in which names of colors seemed to be derived from the same natural objects.

None of the Torres Straits natives were superior in acuteness of hearing to one member of the expedition, while the majority were inferior. No great weight, however, could be attached to the observations, because all the men were divers—an occupa-

tion that certainly damaged the ears to some extent. To investigate their range of hearing a Galton's whistle was used, and it was found that they could hear very high notes.

Their sense of smell was tested by means of a series of tubes containing solutions, of varying strength, of odorous substances like valerian and camphor, and the results, while not altogether satisfactory, tended to show they had no marked superiority in this respect over the members of the expedition.

With regard to taste it was very difficult to get information, as the natives, naturally enough, did not like strange objects being put into their mouths. One fact, however, was noticed, which was interesting when it is remembered that sweet and bitter are probably our most definite taste sensations, and that was the complete absence of any word for bitter. For the sense of temperature the *data* were very scanty, but it was found that the natives had points on their skin specially sensitive to cold exactly as is the case with Europeans. As to touch, when tested to see how close the points of a pair of compasses must be put on the skin before they ceased to be felt as two, their sensitiveness was in general better than that of the members of the expedition. There is a consensus of opinion that savages are less sensitive to pain than Europeans, but there is always the doubt whether they are really able to bear pain with fortitude. However, the conclusion that the Murray Islanders were distinctly less sentitive than the European in the expedition was supported not only by their subjective statements, but also by objective tests depending on the condition of the skin pressure.

In the discrimination of weight it was curious that these natives who had no abstract idea of weight, and no word to express it, and who, moreover, could have had no practice, were more accurate than a practiced European.

Finally Dr. Rivers, while commenting on the defective knowledge of some of the senses he had treated, and on the absence of comparative *data*, concluded that, in general, the sense organs of the savage were not markedly superior to those of the normal or average European, and that the recorded instances of apparent extraordinary acuteness were to be explained by his habits of observation and specialized knowledge.

---

*OLIVER PAYSON HUBBARD.**

Oliver Payson Hubbard was born in Pomfret, Conn., March 31, 1809, and died in New York, March 9, 1900. After graduating at Yale College in 1828, he remained in that institution as assistant to Professor Silliman until he began his study of medicine, which he completed in 1837, when he received the degree of M.D. from the South Carolina Medical College, at Charleston.

Prior to his graduation in medicine, he was made professor of chemistry, pharmacy, geology and mineralogy in Dartmouth College. In 1871 the chair was restricted to chemistry and pharmacy, and no longer required his full time, so that he was able soon afterwards to make New York his home during much of the year. In 1883 he felt that he had already passed the age when one should retire from a professorship, and resigned his position, becoming *professor emeritus*. Thereafter he remained in New York City.

His youthful love of science led him to Yale, that he might study under Professor Silliman, then the prominent teacher of science in our country. His first publication, entitled 'Geological and Mineralogical Notices,' having reference to localities in northern New York, appeared in the *American Journal of Science* in 1837, and was followed in 1838 by a somewhat more elaborate article upon the White Mountains.

* Read before the meeting of the Section of Geology and Mineralogy of the New York Academy of Sciences on April 16, 1900.

He attended the 1841 meeting of the Association of American Geologists and Naturalists and read a paper of capital importance upon the slates of Waterville, Maine, in which he discussed the markings upon the slates and indicated their organic origin, which he regarded as proving their great age. He was present also at the third meeting and took a prominent part in the discussion of the 'drift' so that he was appointed member of the committee to prepare a report upon that subject for the next meeting. He was elected secretary of the Association for 1843 and, with Benjamin Silliman, Jr., served in the same office for 1844. His duties at Dartmouth were exacting, so that for many years he published few extended papers, but he made many brief communications to societies, all of which were characterized by keen discrimination and many of them were important contributions.

Doctor Hubbard joined this Academy in 1874 and at once became so active that when Mr. Browne, who had been Recording Secretary from 1839, resigned in 1875, Professor Hubbard was chosen as his successor. He retained this office until 1885, when he became Vice-President. At the death of Doctor Newberry in 1892, he was made President, but he served for only one term, declining re-election because of his advanced years. From 1874 until 1893 he rarely failed to attend the meetings, when in the city, and he always presented something of interest bearing upon matters under consideration. His manner was courteous to the last degree and he understood well how to discuss without disputing.

Professor Hubbard's individuality was very decided; though so gentle and considerate in his manner, he always held positive opinions and, when necessary, did not hesitate to express them. His shrewd common sense made him a good counsel and his advice was sought in many directions. He was a member of the New Hampshire Legislature in 1863–4, but one year's experience in that kind of work sufficed and he declined to be a candidate for re-election. His quiet humor and his store of reminiscences made him a delightful companion. He retained his mental vigor to the last and only two months ago he published an article correcting errors in a recently published work. When ninety years old, he attended the New York meeting of the Geological Society of America and remained throughout an afternoon listening to severely abstract papers, with as much interest, apparently, as though he were just beginning his work.

Professor Hubbard was almost the last link binding our time with that of the early geologists. Hall and Dana died within the last half decade and there remain only Boyé and Lesley of those who attended the earlier meetings of the Association of American Geologists. He passed away in a ripe old age, his life full of good works and his name absolutely unstained. This Academy owes him much, and here his name should be cherished.

J. J. STEVENSON.
ALEX. A. JULIEN.

SCIENTIFIC BOOKS.

The World and the Individual. Gifford Lectures delivered before the University of Aberdeen. First Series; The Four Historical Conceptions of Being. BY JOSIAH ROYCE, Ph.D., Professor of the History of Philosophy in Harvard University. New York, The Macmillan Company. 1900. Crown 8vo. Pp. xiv+588.

The purpose of the Gifford Lectures at the four Scottish universities is now understood pretty well even in foreign countries. The Deed of Gift defines it as the "Promoting, Advancing, Teaching and Diffusing the study of Natural Theology, in the widest sense of that term"; and directs the "lecturers to treat their subject as a strictly natural science, without

reference to or reliance upon any supposed special, exceptional or so-called miraculous revelation." "I wish it considered just as astronomy or chemistry is," the Founder writes. In these circumstances, readers of SCIENCE might expect to find many matters of direct interest in the lectures, especially when they recall that courses have been delivered by Sir George Stokes, Sir Michael Foster, and Professor William James, or that Helmholtz and Lord Kelvin were requested to accept election. It so happens, however, that Natural Theology has been more and more transformed from the semblance of its old self by Metaphysic, during the nineteenth century, and some of the lecturers, like the Master of Balliol and Professor Ward of Cambridge University, and now Professor Royce, attach principal importance to this aspect of the inquiry. Thus, although Mr. Royce's 'Supplementary Essay,' on the One, the Many, and the Infinite, cannot but attract mathematicians, especially such as are concerned about the theory of numbers, his book does not appear, otherwise, to contain much matter of direct moment for readers of this JOURNAL. I say 'appear' advisedly; for here, as so often, appearances happen to be deceitful.

Although the whole of Mr. Royce's work is metaphysical, and sometimes very technically metaphysical, there are but two of the ten lectures (i and iv) which possess little direct bearing upon that scientific view of the universe formulated almost entirely since the time of Laplace. Further, lectures iii, v, vi, vii, viii and ix are of vital importance for contemporary conclusions regarding, not what man *can* know, but what he *does* know—must know in the nature of the case. The titles of these discourses are as follows:—the Independent Beings—a Critical Examination of Realism; the Outcome of Mysticism, and the World of Modern Critical Rationalism; Validity and Experience; the Internal and External Meaning of Ideas; the Fourth Conception of Being; Universality and Unity.

Everyone knows that the sciences, not excepting psychology, presuppose a dualistic attitude towards human experience, for the very simple and very defensible reason that this best consorts with the impartiality necessary to obtaining the most accurate results. So long as he confines himself to his observations and experiments, no scientific man doubts that there is a world of real being existing on its own account in entire independence of thought or its processes. Nevertheless, and curiously enough, he also never doubts—for here lies the whole vitality of his quest—that he can obtain valid knowledge of this foreign sphere. Further, and still more curiously, he is perfectly willing to accept the conclusions of others as valid—co-operation being one leading note of contemporary science. In a word, paradox though it be, dualism and the negation of dualism are equally presuppositions of detailed scientific inquiry. Hence originates what Mr. Royce calls realism, the dogma critically examined and conclusively shown to be untenable in his third chapter. But, while this dualistic metaphysic—unconscious albeit—could remain complacent and, but for Berkeley, comparatively undisturbed, throughout the domination of what has been aptly called the astronomical (or molar) view of the universe, more modern researches, particularly in the field of physiology, gave it the lie direct and from the strictly scientific side. Physiological physics set dualism somersaulting. As Helmholtz said: "I hold that to speak of our ideas of things as having any other than a practical value is absolutely meaningless. They can be nothing but symbols, natural signs, which we learn to use for the regulation of our movements and actions. When we have learned to read these symbols aright, we are able with their aid to direct our actions so that they shall have the desired results; that is, that the expected new sensation shall arise." Or, as Huxley put it, even more pointedly: "All that we know about motion is that it is a name for certain changes in the relation of our visual, tactile and muscular sensations. . . . It is as absurd to suppose that muskiness is a quality inherent in one plant as it would be to imagine that pain is a quality inherent in another, because we feel pain when a thorn pricks the finger." Here we discover the root of that Critical Rationalism, so popular with scientific men during the past generation, and now subjected to such merciless exposure in Mr. Royce's fifth and

sixth lectures. The other lectures, already noted as of importance to scientific readers, really deal with the metaphysical conclusions which modern inquiry, broadly viewed as a whole, most fully warrants. They constitute the first attempt in the United States, so far as I know, to supply a reasoned account of first principles from the standpoint—the only reasonable, and therefore the only defensible one as I think—that human experience is a closed circle, and that if it is to be justified at all, justification must proceed from within this circle.

This is not the place to attempt an estimate of Mr. Royce's contribution to 'natural theology' (*i. e.*, philosophy of religion); moreover, it were more just not to anticipate his second series of lectures, in which he promises to apply his principles. I wish, in conclusion, to draw the attention of mathematicians to the importance of the Supplementary Essay. Written in reply to Mr. F. H. Bradley's conclusions, in 'Appearance and Reality,' it is necessarily of a most technical character. But its suggestiveness will repay some effort. It will serve, also, as I believe, to render many more completely conscious of the change that the last fifty years have wrought upon the old ideals of definiteness and accuracy. These, indispensable desiderata as they are, possess certain limitations. Perception of these limitations has led some to reconsider conceptions once deemed fundamental without question. No doubt, as Mr. C. S. Peirce seems to indicate (SCIENCE, No. 272, pp. 430 ff.), Mr. Royce may be mistaken regarding some matters that lie specially within the purview of the mathematical expert. But, all the same, so far as I am capable of judging, no one can fail to be stimulated by his discussion, not merely of Bradley, but also of Cantor and Dedekind. If he were to have formulated no more than a forcible illustration of the intimate connection between mathematical and metaphysical problems, he would have earned our warm congratulations.

It need hardly be added that the book is one with which all workers in Professor Royce's own field will have to reckon.

R. M. WENLEY.

UNIVERSITY OF MICHIGAN.

A Preliminary Report on the Geology of Louisiana. By GILBERT D. HARRIS and A. C. VEATCH. Baton Rouge. 1900. 8vo. Pp. 354. Pl. 62.

This report on the geology of Louisiana is the first annual report of Professor Harris and one of a series of annual State reports bearing on agriculture, geology, and the development of the State, which are issued under the auspices of the State Board of Agriculture, and distributed free on application. It covers the operations for the season of 1899, and in printing, illustration, etc., is very well gotten up, though, as in many State reports, there are rather more than a fair share of typographical errors. There is an excellent index which is a boon to be thankful for, though, curiously enough, there is nowhere any date of publication.

The contents are divided into three sections (I) an historical synopsis of previous geological work done in the State; (II) general geology; and (III) special reports by various authors, in this case including the geology of the salt mines of the Five Islands, reports on clays, on fossil plants and invertebrates and a popular article on fungi injurious to standing timber.

From the well-known energy and acquirements of the geologist in charge, ably assisted by Mr. Veatch, one naturally expects the clearing up of problems which have long puzzled geologists, with other positive additions to geological knowledge. And, since Professor Harris is a paleontologist and stratigrapher, we do not expect to see complicated questions settled off-hand on the physiographic aspect of a few gravel banks. Nor are these anticipations disappointed.

Earlier workers, especially Hilgard, have insisted on the presence of cretaceous rocks in Louisiana, but their distribution has been more or less uncertain and in the absence of skilled paleontological assistance Lower Eocene fossils have been sometimes taken for Cretaceous remains, etc. One important result of the current work has been the establishment of the fact that the upper Cretaceous (Ripley) under its blanket of Tertiary strata, extends, with a general parallelism to the old Eocene shore line, in many folds in a NE–SW direction. A fairly good list of Cretaceous fossils has been secured,

though, as in the other strata of the State, the preservation of the fossils leaves much to be desired. It is to be regretted that the absurd pale yellows allotted by international agreement to the Tertiary, make it almost impossible to prepare an intelligible map of a Tertiary region in color. We should advise Professor Harris in future to use plain black and white symbols for this purpose.

The work on the Tertiary accomplished by this survey is most important, and would have been impossible for any one less versed in the lower Eocene paleontology than Professor Harris. He demonstrates the presence of the Midway horizon in Louisiana, for the first time, in two localities and further search will doubtless reveal others.

The Chickasawan (Mansfield of Hilgard's earlier work and one of the multitudinous 'Lignitics' of authors) is now found to cover a large area in Louisiana. Parts of it, through absence of expert paleontological knowledge, have been referred to the Vicksburg, Jackson, Claiborne and other subdivisions of the Eocene, in earlier work. Now we have its boundaries approximately defined and a well illustrated faunal list of species provided. In future work we trust Professor Harris will discard entirely the obsolete and misleading name of Lignitic and adopt the geographical term for this stage which is accepted by the majority of geologists interested in this horizon.

Jacksonian strata extend, as the author shows, from the Oachita river to the Texas boundary, while the Oligocene beds of the Vicksburg horizon are confined to the region between the Oachita and Red rivers.

Considering the small appropriation available for the work, the State of Louisiana is to be congratulated on the amount and quality of that which has been accomplished. It is to be hoped that Professor Harris may be able to continue his labors, and that the perplexities presented by the Pleistocene deposits of the State may yield to persistent study in the future.

W. H. Dall.

The Physiological Rôle of Mineral Nutrients. By Dr. Oscar Loew. Bull. 18, U. S. Dept. of Agriculture. 1899.

Dr. Loew discusses the actual part of the various mineral substances in the physiology of the vegetable organism, a matter of prime importance to the agricultural experimenter, as well as the botanist. Every advance in this subject has been won by the most arduous labor, and only in a few instances may the conclusions reached be considered as final.

The treatment of such an unsettled subject within the limits of a bulletin must result in many omissions in order to bring points of the greatest interest prominently to the attention. By reason of such necessity one does not find the names of Wieglieb, Marcgraf, Senebier, or Boussingault in the historical resumé of the subject, which otherwise traces the course of investigation on the subject somewhat clearly.

Phosphoric acid is necessary for the formation of the essential constituents of the nucleus and plastids, inclusive of the chloroplasts and chlorophyll; secondary potassium phosphates are found in combination with certain proteins; iron takes part in the formation of chlorophyll although it does not enter into the composition of the molecule of this substance, and is not to be considered of more importance in this connection than many other substances. Attempts to replace iron with manganese have met failure so far. Chorides are necessary for but few species; they are taken up in quantity by aquatics and other plants however.

The presence of potassium salts seems necessary for the synthesis and translocation of carbohydrates and proteins. This element may be replaced by rubidium or caesium in certain fungi.

The relation of calcium salts to the translocation of carbohydrates is not clearly defined, but this substance is abundant in all parts of the bodies of the higher forms of plants. It is notable that many of the simpler organisms may exist and attain full development without this element, and Dr. Loew advances the theory that the development of the higher plants both in form and differentiation of function becomes possible only when the capacity to assimilate calcium and use the resulting calcium proteid compounds is acquired; a theory which is based chiefly on coincidence.

Magnesium is found in nuclear substances

and is abundant in embryonic tissues ; its exact rôle cannot be defined. The relation of the element sodium to the organism is most problematical ; it may exert a stimulating effect upon protoplasm, or its presence in the substratum may facilitate beneficial chemical changes. It does not enter into the composition of the plant in appreciable quantity however. The bulletin does not give adequate treatment to the pure mechanical functions of salts in the maintenance of turgidity, and it might have gained in value to the agricultural experimenter by the delineation of lines of practical investigation to be followed. It is highly controversial in parts and one is impressed with the very great differences of conclusions which may be reached from a consideration of the same facts by a comparison with the sections of Pfeffer's Plant Physiology or any other publication treating the same subject.

D. T. MACDOUGAL.

Science Sketches: Chemistry its Evolution and Achievements. By FERDINAND G. WIECHMANN, PhD. New York, William R. Jenkins. 1899. Pp. vii + 176.

The study of the evolution of chemical science from its earliest beginnings possesses a fascinating interest. The author of this little book has endeavored so to present the subject as to make it useful to all who take a general interest in science. In matters which pertain to the development of chemistry before the nineteenth century the treatment is satisfactory. For the present century the book does not altogether succeed in tracing the *evolution* of the science. It seems rather to give a series of more or less isolated facts about the growth of chemical knowledge than to give a clear picture of the development of the science. Perhaps this should not be too severely criticised, for it is immensely difficult to give such a picture for the period in question.

If the theory that diamonds are extra-terrestrial in origin has actually been proposed by any one as suggested on p. 117, it must have arisen from a curious confusion as to Moissan's thought in the matter. Moissan says that in discovering the diamonds in the meteorites he has 'caught nature in the act,' meaning, not that the diamonds were in the meteorites as they flew through space, but that they were formed during the passage of the meteorite through the air and its subsequent cooling. This thought seems to have guided Moissan in his successful production of diamonds.

In the discussion of liquid air the failure to mention the pioneers Cailletet and Pictet is remarkable. Some reference should also have been made to the Linde machines by which liquid air is now produced in quantity on essentially the same principle as that used by Tripler.

W. A. NOYES.

BOOKS RECEIVED.

Scientific Papers. PETER GUTHRIE TAIT. Cambridge, The University Press. 1900. Vol. II. Pp. 500.

Railroad Construction, Theory and Practice. WALTER LORING WEBB. New York, John Wiley & Sons; London, Chapman & Hull, Ltd. 1900. Pp. x + 456.

Introduction to Science. ALEXANDER HILL. London, J. M. Dent & Co. Pp. 140.

SCIENTIFIC JOURNALS AND ARTICLES.

THE April number (Vol. I., No. 2) of the *Transactions* of the American Mathematical Society contains the following articles: 'On the metric geometry of the plane n-line,' by F. Morley; 'On relative motion,' by Alexander S. Chessin; 'Plane cubics and irrational covariant cubics,' by Henry S. White; 'A purely geometric representation of all points in the projective plane,' by Julian Lowell Coolidge; 'The decomposition of the general collineation of space into three skew reflections,' by Edwin B. Wilson; 'A new method of determining the differential parameters and invariants of quadratic differential quantics,' by Heinrich Maschke; 'On the extension of Delaunay's method in the lunar theory to the general problem of planetary motion,' by G. W. Hill; 'On the types of linear partial differential equations of the second order in three independent variables which are unaltered by the transformations of a continuous group,' by J. E. Campbell.

THE May number of the *Bulletin* of the American Mathematical Society contains the following articles: 'On the geometry of the circle,' by Dr. Virgil Snyder; 'Isomorphism between

certain systems of simple linear groups,' by Professor L. E. Dickson; 'The Hessian of the cubic surface,' by Dr. J. I. Hutchinson; 'Note on the group of isomorphisms,' by Dr. G. A. Miller; a review by Professor F. S. Woods of two memoirs by Lobachevsky, translated from the Russian by Engel; a review by Professor James Pierpont of Vogt's Leçons sur la resolution algébrique des equations; a review by Professor L. E. Dickson of Young and Linebarger's Elements of the Differential and Integral Calculus; a review by Mr. J. K. Whittemore, of Pascal's Calculus of Variations; 'Notes'; and 'New Publications.'

The *Botanical Gazette* for April contains a new study of *Isoetes* by Dr. R. Wilson Smith, of the Hull Botanical Laboratory. It is concerned with the structure and development of the sporophylls and sporangia, and is illustrated by eight plates. The paper is a valuable contribution to our knowledge of the structure and relationships of a much vexed group. Dr. Roland Thaxter publishes concerning the structure and reproduction of *Compsopogon*, a peculiar group of filamentous blue-green algæ, andillustrated by a single plate. Dr. J. C. Arthur publishes the results of cultures of Uredineæ in 1899, giving eleven species whose aecidial and teleutosporic forms have been definitely connected. C. Sauvageau writes concerning the origin of the thallus, alternation of generations, and the phylogeny of *Cutleria*. The number also contains the usual installment of book reviews, notes for students, and items of botanical news.

The *News Bulletin*, Number 4, of the New York Zoological Society, contains several fine pictures of animals now in the Society's park, as well as two showing methods of installation. The most striking of these is the Alligator Pool in the reptile house which with its background of palms has a pleasing suggestion of the tropics about it; the pool proper is 35 feet long, 9 feet wide and 4 feet deep, giving ample space for its occupants. It is noted that the largest alligator has added four inches to the length of twelve feet and one inch which it possessed when brought from Indian River in July, 1899. This seems rather a rapid rate of growth for so large an alligator. The water birds are reported to be passing successfully through their spring moult and we look to the park for some tangible evidence for or against the vexed question of color change in feathers without moult. In the bird house the experiment has been tried of decorating the walls which form the backs of the cases with landscapes and this has been done so successfully by Mr. Robert Blum that the cranes have several times tried to walk through the wall. A call is made for new members as funds are needed for various improvements and for immediate expenses, and it is to be hoped that the admirable showing already made may cause this call to be listened to.

The leading article in *The American Naturalist* for April is by George James Peirce, on 'The Relation of Fungus and Alga in Lichens,' and the author considers that the association is one of parasitism of the former upon the latter. Howard Crawley describes 'A Flagellated Heliozoan,' which he considers a form of *Vampyrella lateritia*, and H. S. Jennings presents a paper on 'Reactions of Infusoria to Chemicals: a Criticism' of a paper by W. E. Garrey. L. B. Walton discusses 'The Basal Segments of the Hexapod Leg,' attempting to homologize and account for the origin of these parts, and R. W. Shufeldt has some 'Notes on the Psychology of Fishes.' Frank C. Baker describes 'A New Museum Tablet' of binders' board, edged with black and faced with manilla paper, and T. D. A. Cockerell treats at some length the question of 'The Lower and Middle Sonoran Zones in Arizona and New Mexico,' in which he shows that in the arid west the influence of fluctuations of temperature is much greater upon cultivated than upon wild plants, these latter having become adapted to their environment. Under 'Synopses of North American Invertebrates' Harriet Richardson gives a second part of The Isopoda. The reviews are almost entirely confined to those of zoological literature.

The Plant World for April opens with a paper by Mary G. Fanning, on 'Some Algæ in Ornamental Waters.' Sadie F. Price notes 'Abnormal Leaves and Flowers,' E. W. Berry 'Abnor-

mal Forms of Dogwood,' Willard N. Clute has a fifth article on 'The Making of a Herbarium,' and Mrs. Caroline A. Creevey concludes the series devoted to 'Plant Juices and their Commercial Values' with a brief paper on dye plants. C. F. Saunders notices 'The Small Mistletoe in Pennsylvania,' and the editor comments on forest preservation. Charles Louis Pollard, in the supplement presenting the 'Families of Flowering Plants,' treats of the order Glumifloræ—the grasses and sedges.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 323d regular meeting was held on Saturday, April 5th. C. H. Townsend spoke of 'The Flying Foxes of the South Pacific Islands' under this title describing the fruit bats, *Pteropus*, found during the recent voyage of the United States Fish Commission steamer *Albatross*, and illustrating his remarks with lantern slides and specimens. The speaker stated that no bats were found in Polynesia to the eastward of the Tonga and Samoa groups although search was made for them.

A large rookery of flying foxes on the island of Tongatatu was visited and many fine photographs were taken showing the bats clinging in large numbers to the tree-tops. The rookery is located in a small native settlement near Nukalofa, the bats about 8000 in number, occupying the tops of 14 large trees in the midst of the village. The rookery is carefully protected by the chief of the village, who permitted the naturalist to take away only three specimens. It was understood that they had been guarded by the people from time immemorial, although the animals are frugivorous and evidences of their depredations on the island fruits were found constantly.

Mr. Townsend collected many flying foxes at Namuka Island (Tonga group), where they were found scattered in the forest. They were seen in the Fiji and Samoan islands also but no specimens were secured.

In a paper entitled, 'Acorns as Food,' Mr. V. K. Chesnut, after briefly mentioning the various places where sweet acorns are, or were, used for human food along the Mediterranean and in the United States and Mexico, gave a special illustrated account of the interesting manufacturing and chemical processes which have gradually been evolved by the Indians of Mendocino County, California, to extract the tannin and the bitter principle from the bitter acorns. The acorns of the black oak (*Quercus californica*), chestnut oak (*Q. densiflora*), and valley white oak (*Q. lobata*), especially, constitute an important and almost essential portion of the food of these Indians during the greater part of the year.

Mr. W. A. Orton spoke on the 'Sap-flow of the Maple' in spring, giving a brief description of the methods of making maple sugar and a report of some of the investigations made at the Vermont Experiment Station under the direction of Professor L. R. Jones. Sap pressure and flow in the sugar-maple occurs at intervals from October to May, when the weather conditions are favorable, but is most active for a month during March or April. To produce sap-flow it is necessary that the temperature should rise from several degrees below the freezing-point to some degrees above it. If this change be at all sudden there will be developed a pressure within the tree of 15–25 or more lbs. per square inch. Charts showing the relation of the temperatures as measured by a self-recording thermometer, to the sap-pressure recorded by a self-recording steam-pressure gauge attached to a maple tree were exhibited, and it was shown that in general there was a very close relation between sudden rises of temperature and of sap-pressure, there being pressure on warm days followed by suction at night. Sap flow diminished toward the top of the tree. It was greatest in the outer part of the tree, but continued longer from deeper in the wood. It was concluded that the cause of sap-flow was physical rather than physiological, being due to the expansion of confined air and water in the vessels of the wood, brought about by a sudden rise of temperature. There is little if any root-pressure during the season of sap-flow, and as the trees are dormant the old question of ascent of water from roots to leaves hardly enters into the problem. The direction of sap-flow was studied by injecting lithium into the tree near the tap-hole and testing the sap with a spectroscope. It was found that

sap moves freely both up and down toward the tap-hole *with* the grain of the wood, but very little or not at all *across* the grain.

Other problems mentioned are still under investigation. F. A. Lucas.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF GEOLOGY AND MINERALOGY.

The meeting on April 16, 1900, was held at 12 West 31st Street, Dr. A. A. Julien presiding and 29 persons present.

Professor Stevenson, in behalf of the committee appointed to prepare a minute respecting the late Professor Hubbard, presented an obituary notice which is published on page 742 above.

Dr. R. Ellsworth Call presented 'Some Preliminary Notes on Crystal Growths in Mammoth Cave.' He first gave a brief resumé of the geology of the vicinity of Mammoth Cave. The strata making the geologic section are nearly horizontal and all the rocks forming the cavern are of sub-carboniferous age. The region of the cavern is capped with sandstones of the Chester Group 500 feet thick, beneath which are oölitic and other limestones, in which the cavern is excavated to a thickness of over 350 feet. The drainage level of the cavern is determined by the present level of Green River. Five different levels have existed during geologic time. No gypsiferous strata are known in the region. The overlying sandstone is usually quite ferruginous; but no pyrite occurs in either strata. Secondary crystallization has occurred in many of the stalactites causing them to simulate the fibrous appearance sometimes assumed by aragonite. The stalactites of recent origin almost all have a downward-projecting tree root as their origin of fixation, or are beneath sink-holes. The chief objects of mineralogical interest are the gypsum crystals which cover the sides and ceilings of certain avenues in the cavern, in the upper of the five levels only, and not in any levels now occupied by streams. These crystals are sometimes curiously and remarkably contorted and the terminations of the crystal masses are often recurved in a direction contrary to the direction of gravitation. Occasionally the gypsum assumes a botryoidal form, but is commonly found as needles or aggregated in loose masses of fibrous crystals. The gypsum crystals occur only along cracks, and are built up by increase from the base, while the calcium-carbonate stalactites are always built up by additions to their surface or terminations. It is difficult to account for the large amount of sulphur needed by assuming its origin in organic bodies, such as plants and the forests which are now of abundant growth in the region and have been so for geologic ages. The origin of the carbon dioxide necessary for the great work of solution which has been accomplished is likewise found in the decaying vegetation. The origin of the sulphuric acid required to produce these enormous quantities of gypsum crystals, which have fallen so abundantly as to fill up certain avenues, is still problematic. Only one other mineral is found, flocculent crystals of magnesium sulphate, pendant from the ceiling of two or three small rooms. There are no calcite or quartz crystals. The paper was illustrated by lantern slides showing the peculiarities of the stalactite and gypsum formations.

Professor Kemp, in discussion, suggested that the small percentage of sulphur present in the limestones themselves might, after solution of the latter, aggregate sufficient sulphur to afford gypsum along the crevices. Doctor Julien and Professor Stevenson each cited cases in the Caribbean and Bermuda Islands where the amount of vegetation now or formerly growing on the surface was insufficient to accomplish the solution required for the great caves which exist in the coral limestones, both of tertiary and recent growth in the islands.

A paper by Doctor E. O. Hovey, on the 'Scenery of the Harney Park District in the Black Hills, South Dakota' (illustrated with lantern slides), was read by Professor Kemp, owing to the former's unavoidable absence. After a brief resumé of the geology of the Black Hills district, a series of views was shown illustrative of the extraordinary erosion forms of the schists and pegmatites of the Harney Peak district. The photographs also showed the tin mines of the Black Hills, in which spodumene crystals of large size have recently been obtained as a valuable source of Lithium, as a commercial product. One spodumene crystal

here obtained was thirty feet long. The granite veins have also been described by Van Hise.

Discussion followed on occurrences of extraordinarily large crystals of other minerals.

THEODORE G. WHITE,
Secretary of Section.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis, on the evening of April 16th, Mr. Herbert F. Roberts, of the Henry Shaw School of Botany, addressed the Academy on 'The Structure and Physiology of the Cell in the Plant Organism.' The history and development of cytology as a special field in biology were traced, and the origin of the various theories of cell organization was indicated. The development of various theories respecting the centrosome and its rôle in cell division was discussed, the homologues of the centrosome to be found in ciliated cells and spermatozoa being indicated. After a review of the processes of cell division and their attendant phenomena, the methods of study of mitoses in plants and their proper illustration were considered. A great need exists for more accurate processes of reproduction than is afforded by plates made from camera lucida drawings. The latter are always more or less diagrammatic, and are apt to be modified by the personal bias of the investigator. Unconsciously the personal equation enters in. This is seen in recent work on the subject of the existence of the centrosome in higher plants. The difficulty referred to can be overcome by the employment of photomicrography. This has been made use of to a limited extent by zoologists in the study of mitoses, but apparently scarcely at all by botanists. The speaker showed some forty prints from photomicrographic negatives showing mitoses in rhizomes of *Erythronium albidum* and in microspore mother cells, and microspores in *Lilium philadelphicum* and *Pinus laricio* and megaspores in *Lilium Canadense*. The possibility which photomicrography affords, of giving structural details with relative fidelity, was illustrated by these photographs and by lantern slides.

Eight persons were elected active members of the Academy.

WILLIAM TRELEASE,
Recording Secretary.

AMERICAN MATHEMATICAL SOCIETY.

A REGULAR meeting of the Society was held at Columbia University on Saturday, April 28, 1900. As has grown to be the custom, a portion of the day was set apart for a joint meeting with the American Physical Society, at which papers noted below were read by Professors E. W. Brown and R. S. Woodward. President Woodward occupied the chair, yielding it during the joint session to Professor Hallock, of the Physical Society. The amendments to the constitution outlined in the report of the February meeting were adopted. The following persons were admitted to membership: Professor R. D. Ford, St. Lawrence University, Canton, N. Y.; Dr. L. W. Reid, Princeton University, Princeton, N. J. Eight applications for membership were received.

The following papers were presented at this meeting:

(1) DR. VIRGIL SNYDER: 'On some invariant scrolls in collineations which leave a group of five points invariant.'

(2) MR. A. S. GALE: 'Note on four theorems of Chasles.'

(3) PROFESSOR CHARLOTTE ANGAS SCOTT: 'A theorem on quadrilaterals in space.'

(4) MR. F. H. LOUD: 'Sundry theorems concerning n lines in a plane.'

(5) DR. E. J. WILCZYNSKI: 'Transformation of systems of linear differential equations.'

(6) PROFESSOR FLORIAN CAJORI: 'Semi-convergent and divergent series whose product is absolutely convergent.'

(7) PROFESSOR E. W. BROWN: 'A possible explanation of the eleven year period of sunspot activity.'

(8) PROFESSOR R. S. WOODWARD: 'An elementary method of integrating certain linear differential equations.'

(9) DR. G. A. MILLER: 'On a certain class of abelian groups.'

(10) PROFESSOR H. B. NEWSON: 'On singular transformation and continuous groups.'

(11) PROFESSOR E. O. LOVETT: 'Group theory and geometry of four dimensions.'

(12) PROFESSOR E. O. LOVETT: 'The condition that a linear total differential equation be integrable.'

(13) PROFESSOR C. H. HINTON: 'Observations on the principle of duality.'

After the meeting several members of the Mathematical and the Physical Societies dined and passed the evening agreeably together.

The summer meeting of the Society will be held at Columbia University, June 27th–30th in connection with the meeting of the American Association. F. N. Cole, *Secretary.*

Columbia University.

NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

The regular monthly meeting of the New York Section of the American Chemical Society was held on Friday evening, April 6th, at the Chemists' Club, 108 West Fifty-fifth street. Dr. C. F. McKenna presided, and the following papers were read;

'A Method of Obtaining Nucleic Acid,' by Dr. P. A. Levene.

'Analysis of a Saline Deposit from Southern Nevada,' by Ralph W. Bailey.

'Notes on the Ferrocyanide Titration of Zinc,' by Dr. E. H. Miller and E. J. Hall.

Special announcement was made of an extra meeting to be held on May 2d, for the exhibition of novel forms of apparatus, products, etc., and that the meeting would be in the nature of a reception, to which the ladies and friends of the members would be invited. The Section on this occasion will be the guest of the Chemists' Club.

An invitation to attend the next meeting of the New York Section of the Society of Chemical Industry, to hear a paper on 'Petroleum and its Products,' by Dr. C. F. Newberry, signed by Dr. Parker, was then read, after which the meeting adjourned.

Durand Woodman,
Secretary.

DISCUSSION AND CORRESPONDENCE.

PHYSICAL OBSERVATIONS DURING THE TOTAL SOLAR ECLIPSE.

To the Editor of Science: While the most important observations during the total eclipse of the sun are, of course, astronomical, some simple physical observations can be made with little or no apparatus and may serve to elucidate two obscure atmospheric phenomena, namely, the so-called 'shadow-bands' and the changes in the direction and velocity of the wind.

Professor R. W. Wood, in Science of April 27, has described the appearance of the shadow-bands and has given instructions for observing them, so that, although I myself had prepared a circular of instructions for co-operating observers, yet, in consequence of the fact that so able a physicist as Professor Wood will study this phenomenon, I shall be glad to send him my own observations and any that I may receive. It may be interesting here to state briefly the results of the observations made and collected by Professor Winslow Upton, Mr. A. E. Douglass and myself during total solar eclipses. In the eclipse of August 19, 1887, observed in Russia, it was cloudy and no shadow-bands were seen, but in the eclipse of January 1, 1889, observed in California with a clear sky, the bands were well defined, though an attempt to photograph them failed. They were more prominent at high altitudes than at low levels, but they seem to have no connection with the position of the stations in or near the shadow-belt. While the reports of the various observers indicated a general agreement for the direction in which the bands lay, yet there was no uniformity in the direction of progression which seemed not to be related to the direction of the wind. In every case the speed of the bands was much less than that of the shadow itself, thus disproving the theory that the bands are diffraction fringes in the shadow of the moon. The observations are discussed by Professor Upton and myself in Vol. XXIX., No. 1, *Annals Astron. Observatory of Harvard College.* During the eclipse of April 16, 1893, observed in Chile under the most favorable circumstances, the shadow-bands were very generally seen immediately after totality. They lay approximately northwest and southeast, and moved mostly towards the southwest at a speed variously estimated at from three to twenty miles an hour. The width of the bands appeared to vary from one-eighth of an inch to four inches, and their distance apart from one to ten inches. A significant fact was that, contrary to the observations in the previous eclipse, the bands were much less conspicuous on the mountain summit, occupied by the writer, than near sea-level, where they were also coarser, thus indicating the effect of increased thickness of atmosphere.

The many reports which were collected about the 'eclipse-wind,' so-called by the late Mr. Ranyard (*Memoirs Roy. Astr. Soc.*, Vol. XLI., Chap. XXXV.), show that some change in the direction and velocity of the wind usually occurs. Theoretically, the passage of the moon's shadow, by suddenly chilling the atmosphere, ought to increase the barometric pressure along its path and so cause an outflow of air in all directions. Investigations to determine the amount of this change of pressure were made by Professor Upton and the writer during the eclipses previously mentioned with the result that the changes which could be attributed to the eclipses were found to be too small to measure directly, even with most sensitive barometers. But a very slight gradient suffices to deflect the wind or to alter its velocity and this effect was detected by us (see *Amer. Meteorological Journal*, Vol. IV., and *Annals Harvard Observatory*, previously cited). At a station traversed by the shadow there should be a deflection of the wind contrary to clock-hands before totality and a movement in the opposite direction after the shadow has passed, if the wind blows from the northern side of the eclipse track, or *vice versa* if the wind blows from the southern side. A wind having the same general direction as the shadow should be accelerated when the shadow advances and retarded when it recedes, and a wind blowing into the advancing shadow should be diminished before this arrives and increased afterwards. During totality a lull in the wind might be expected, analogous to the calm experienced in the center of an anti-cyclone.

Although some of these effects have been perceived, observations in various parts of the shadow-belt are desired in order to confirm or disprove the theory. Therefore, I shall be glad to receive any information about the changes of the wind near the surface of the ground and high up in the atmosphere during the coming eclipse. To determine the direction and strength of the surface-wind a light streamer, or pennant, attached to a freely exposed pole, may be observed several times just before and just after totality, while, if high clouds are visible, a single observation of their drift before and after totality will give the direction of the upper wind with sufficient accuracy.

A. LAWRENCE ROTCH.

BLUE HILL METEOROLOGICAL OBSERVATORY, HYDE PARK, MASS.

THE UNIVERSITY OF CINCINNATI.

TO THE EDITOR OF SCIENCE: In my statement regarding the situation at the University of Cincinnati, as published in your issue of April 27th, the omission of four words, in a short paragraph on page 669, results in an erroneous statement.

The sentence should read: "During the greater part of the twenty-five years which have elapsed since the organization of the university, the institution has been without a president."

THOMAS FRENCH, JR.

'00 OR 1900.

THE use of the *year of publication* in its full or in its abbreviated form is coming into very general use as a 'catch title' in bibliographic lists and citations. The abbreviated form, *e. g.*, '97, for 1897, cannot be used for more than one century without ambiguity. There are two possibilities concerning the usuage of the abbreviation '00; it may stand for either 1900 or for 1800. It is desirable that usuage should be uniform. Since the use of the abbreviated form began in the present century,—about 1880, if I am not mistaken,—the omitted figures have always been 18. It seems to me that that is reason enough why we should use '00 always to mean 1800, not 1900, even though the current year belongs to the twentieth century. Thus the apostrophe would without exception stand for the same omitted figures, 18.

E. L. MARK.

HARVARD UNIVERSITY,
April 20, 1900.

CURRENT NOTES ON PHYSIOGRAPHY.

THE MEXICAN BOUNDARY.

THE 'Report of the Boundary Commission upon the survey and re-marking of the boundary between the United States and Mexico, west of the Rio Grande, 1891–1896' (Washington, 1899) includes a chapter devoted to a general description of the country adjacent to the international boundary line, of which the most notable features, in addition to the marked

aridity of the climate and to the great scarcity of perennial streams, are the "bare, jagged mountains rising out of the plains, 'like islands from the sea,' the abundance of the evidences of volcanic action in times geologically recent, the parallelism of the mountain ranges with one another and with the Pacific coast, the general absence of trees, the preponderance of evergreen vegetation, with its dull, leaden-green hue, the prevalance of thorns in nearly all vegetation, the general absence of fragrance in flowers, * * * and the abundance and large size of the cactus." The trail across the Yuma desert passes numerous graves or monuments to travelers who lost their lives from thirst. Besides the volume of text, with 49 plates, there is an atlas containing an index map, 19 detailed maps on scale of 1 : 60,000 with sketched contours, and five plates of profiles, and an album of 258 excellent plates reproduced from photographs of the boundary monuments, and showing, incidentally, an unequalled series of landscapes of that desert region.

GLACIATION OF SIERRA COSTA, CALIFORNIA.

THE 'Ancient Alpine glaciers of the Sierra Costa mountains in [northwest] California,' are described by O. H. Hershey (*Journ. Geol.*, vii, 1900, 42–77). The peaks reach 7000 to 9000 feet. Non-glaciated valleys are V-shaped, hardly wider at the bottom than their streams, and with ragged spurs projecting from their sides. Where the walls are of serpentine, land slips have occurred, forming hummocky, moraine-like masses in the valley bottom. If followed up to their glaciated stretches, they become open U-shaped, with smooth slopes, free from lateral ravines and spurs. Above the smoothed glacial channels, the mountain slopes are still ragged, deeply scored with ravines. Lateral moraines are well developed; terminal moraines are less distinct. The heads of the main and branch glaciated valleys are cliff-walled corries, often holding small rock-basin lakes. Meadows of bog and grass occupy portions of the upper valley floors, as if replacing shallow lakes. Further down, the trunk valley floors are often broken by precipitous steps from one to five hundred feet high.

A curious case of stream diversion by glacial action is described. The upper part of the valley of Coffee creek (descending northeastward) had in preglacial time a higher floor than the neighboring upper part of the next valley on the west, that of South fork of Salmon river (descending northward), the two being separated by a low dividing ridge. The glacier of Coffee creek obstructed its own valley by a moraine several hundred feet thick, and at the same time ran over a sag in the low lateral divide and descended westward into the adjacent deeper valley, wearing down a gorge through the sag. Hence the present head of the South fork of Salmon river rises in the head of the former Coffee creek valley, follows it for five miles to the valley-floor moraine, within a few hundred yards of the present head of Coffee creek, then turns west through a narrow and rapidly descending cleft and thus deserts the Trinity for the Klamath river system.

THE TROUGH OF LAKE NYASSA.

THE suggestion made by Thomson in 1882 that Lake Nyassa in southeast Africa lies in a down-vaulted trough or *Graben* is confirmed by Bornhardt (*Verhandl. Gesellsch. f. Erdk.*, Berlin, xxvi, 1899, 437–452). The lake surface is 500 meters above sea-level; its bottom sinks several hundred meters below sea level. On either side are highlands from 1000 to 2000 meters in altitude. Fault breccias occur along the border of the trough. The highlands on the northeast where traversed by Bornhardt, consist in part of gneiss and granite. At a moderate distance back from the rapid descent to the lake, the highland surface presents gentle undulations with broad and shallow valleys of gentle fall, while the border of the highland for 10 or 15 kil. back from the trough is trenched by torrential streams in deep valleys of rapid fall, and the rolling surface is there transformed into a series of ragged ridges, scored by steep ravines. Here erosion is in its youthful stage; on the broader highland surface erosion has reached a stage of repose (*Ruhestand*) at the close of a long undisturbed period. The activity of the young streams in the highland border indicates a geologically recent date for the production of the trough.

W. M. DAVIS.

THE MAKING OF A MUSEUM.

Mr. L. P. GRATACAP has reprinted, as a separate, his article on Museums which originally appeared in the pages of the *Architectural Record*, and the pamphlet makes an acceptable contribution to museum literature. Many of the points in the making of a museum from the general style of the building to small details of installation are well and concisely treated and frequent diagrams help to a better understanding of the text. On most points the reader will find himself in substantial accord with Mr. Gratacap, but some of the dicta must be regarded as expressions of individual opinion rather than of a general agreement on the points at issue. The personal equation will more or less unconsciously influence the opinions of any one writing on the subject of museums and what would meet with the unqualified approval of an ornithologist might not please an invertebrate paleontologist. If any apology is needed for noting that there are differences of opinion concerning the correctness of some of Mr. Gratacap's views it is to be found in the fact that the growing interest in museums, the large sums of money involved in their construction and maintenance, and the great value, in every sense of the word, of their collections seem to demand a careful consideration of all details of construction and installation.

Light is a question of vital importance to a museum, but Mr. Gratacap tells us nothing of the various methods of electric lighting that have been devised especially for museums and nothing of the Luxfer prismatic glass for throwing light into dark corners. And while the lighting of the building as a whole is considered at some length, the question of the window glass is not touched upon. As a matter of individual opinion the windows of a museum should be of ground glass, unless prismatic glass is required for special places, not only to exclude the direct rays of the sun and thus lessen injury to the specimens, but to diffuse the light; any arrangement of curtains that will keep out the sun will deaden the light also. The alcove system of arrangement is discussed and the statement made that by this method table cases are excluded. What has always seemed an ideal arrangement, and one that was shown to good advantage in the exhibit of the U. S. National Museum at Chicago, and may now be seen in portions of the Field Columbian Museum, is the alcove system with table cases in the center of the alcove; if there is any better plan than this, where there is sufficient overhead light, the writer has yet to see it.

Passing to the cases themselves it may be said that the objection to case doors pushing upwards is not that the glass can not be cleaned, an objection that is purely imaginary, but that it is difficult to make such a case dust tight, a difficulty that may be largely overcome by careful construction; on the other hand the size of the glass that may be used in a counterpoised sash, and the ease of handling may be looked upon as offsetting many disadvantages. It is to be doubted if a case can be built with sashes sliding by one another that will be either dust proof or attractive in appearance. For floor cases the double desk case with upright center, sometimes termed a Liverpool case, is most admirable for the display of minerals, shells, or other invertebrates.

Any disposition of shelves must necessarily be adapted to suit the specimens, but it is frequently, if not usually, found in practice that it is decidedly best to have the broadest shelf near the center of the case and a little below the level of the eye. To place the broadest shelf near the bottom of the case prevents the use of the floor for large and bulky objects. As for glass shelves they are often very desirable since they do transmit a great deal of light while not presenting the heavy appearance that is unavoidable where wood is used. While talking of shelves the omission of any mention of the Jenks brackets is a little strange as these are for many purposes much better than any others.

The best methods of exhibiting fossils may as yet be undiscovered, but some excellent beginnings have been made both in the American Museum of Natural History and in the U. S. National Museum, and among these beginnings many consider the use of encaustic, not terra-cotta, tiles which Mr. Gratacap looks upon with doubt. The color and texture of these tiles are agreeable to the eye, their first cost is small, their color is uniform and they do not fade by exposure to light; also specimens which have

been cemented on may be removed by soaking, the tile cleaned and used again. The arrangement of invertebrate fossils mounted on these tiles in almost vertical series enables the collection to be seen at a glance and to be read with the facility of a printed page.

Above all things it should be borne in mind that no hard and fast rules can be laid down for the display of specimens, but that methods must be modified to suit the subject. The main effort of an exhibition series must be to attract, interest and instruct the public and for this purpose a small number of carefully chosen specimens, well installed and well labelled is to be preferred to a multiplicity of objects which fatigue the eye and by their very number prohibit careful examination. The student will always search for information. One great aim of a museum should be to impart knowledge to the visitor who is not looking for it.

F. A. L.

SCIENTIFIC NOTES AND NEWS.

McGILL University has conferred its LL.D. on Professor Geo. F. Barker, of the University of Pennsylvania, on Captain Alfred T. Mahon, U. S. N., and on Mr. J. F. Whiteaves, of the Canadian Geological Survey.

THE Paris Academy of Sciences has elected Professor van der Waals a corresponding member in the place of Sir George Stokes who was recently made a foreign member.

Dr. W. J. HOLLAND, the director of the Carnegie Museum of Pittsburg, has been requested by the trustees of the Carnegie Institute to devote his entire time to the management of the growing departments of that institution. Director Holland is now the chancellor of the Western University of Pennsylvania and the Carnegie trustees are anxious that he should relinquish that position in order to devote his time to the administrative and scientific work of the Institute.

THE tenth award of the Riberi prize of 20,000 lire ($4000) will be made by the Royal Academy of Medicine of Turin, on December 31, 1901, for the best printed or manuscript work, or the most important discovery, during the five years, 1897–1901, in experimental pathology, hygiene, or forensic medicine.

THE Danish Academy of Sciences has elected to foreign memberships Professors E. van Beneden, of Liège; W. Fleming of Kiel; H. Dohrn, of Naples; Th. Engelmann, of Berlin; R. Helmert, of Potsdam; L. Henry, of Lyons; M. Treub, of Buitenzorg, and H. de Vries, of Amsterdam.

MR. ALFRED L. KROEBER, fellow of Columbia University, has been appointed curator of anthropology in the Museum of the Academy of Sciences of California at San Francisco.

MR. R. H. YAPP has been appointed assistant curator of the Herbarium at Cambridge University.

SIR J. BARRY TUKE, known for his studies in mental disease, is a candidate for the vacancy in the parliamentary representation of the Universities of Edinburgh and St. Andrews, caused by the death of Sir William Priestley.

PROFESSOR A. A. MICHELSON of the University of Chicago, has been appointed commander of the First Ship's Crew, Illinois Naval Militia. He is a graduate of Annapolis and served in the navy for several years.

DR. JAMES M. SAFFORD, for many years professor of biology in Vanderbilt University and State geologist of Tennessee, will retire from active work at the close of the present session. Dr. Safford has done a great deal of field work throughout the State of Tennessee, and is also known as the writer of important scientific articles and a valuable work on the geology of Tennessee.

PROFESSOR KITASATO of Tokyo, has discovered a second bacillus which he considers to be an etiological factor in the production of plague. He has also produced a new plague serum.

PROFESSOR JACOB E. REIGHARD, of the department of zoology in the University of Michigan has established a camp on the Huron River near Geddes and is engaged in studying the habits of the dog fish (*Amia Calva*) in its natural surroundings. These are of special interest owing to the fact that after the eggs have been laid the male guards them and the young fish.

THE Council of the British Institution of Civil Engineers has made the following awards for

papers read and discussed before the Institution during the past session: A George Stephenson Medal and a Telford Premium to Sir Lowthian Bell, LL.D., F.R.S.; Telford Medals and Premiums to Mr. H. Dalrymple-Hay, Mr. B. M. Jenkin, Mr. F. W. Bidder, and Mr. F. D. Fox; a Watt Medal and a Telford Premium to Mr. J. Dewrance; a Crampton Prize to Sir Charles Hartley; and Telford Premiums to Mr. C. N. Russell and Mr. R. A. Tatton.

THE executors of estate of the late A. B. Bolton, of Chicago, have presented to the University of Illinois his entomological collection, which is said to be one of the most complete private collections in the world. It is valued at $50,000.

THE death is announced, at the age of 73 years, of Mr. George Highfield Morton, author of publications on the geology of Lancaster and North Wales. He was awarded the Lyell medal of the British Geological Society in 1892.

THE London *Times* calls attention to the fact that M. Alphonse Milne-Edwards, whose death we were compelled to record last week, was the grandson of Mr. Bryan Edwards, M.P., the West India planter and historian, who settled at Bruges, and son of Henri Milne-Edwards, the eminent zoologist, who died in 1885. He was born in Paris in 1835, graduated in medicine in 1859, became professor at the School of Pharmacy in 1865, and in 1876 acted as his father's deputy as professor of zoology at the Jardin des Plantes. He was the colleague of Edmond Perrier in the deep-sea explorations of the *Travailleur* and *Talisman*, and was awarded the gold medal of the Geographical Society. In 1877 he succeeded M. Gervais in the Academy of Sciences, and in 1885 entered the Academy of Medicine. In 1891 he was appointed Professor of Zoology and Director of the Jardin des Plantes, and occupied a house there. His death is a great loss to that institution and to science. Among his numerous scientific works may be mentioned: 'Recherches anatomiques et paléontologiques pour servir à l'histoire des oiseaux fossiles de la France' (1866–1872), 'Recherches sur la faune ornithologique éteinte des Iles Mascareignes et de Madagascar' (1866–1874), 'Éléments de l'histoire naturelle des animaux' (1881–1882), 'Expéditions scientifiques du travailleur et du talisman pendant les années 1881, 1882, et 1888,' and the papers on mammals and birds in Grandidier's 'Histoire physique naturelle et politique de Madagascar.'

AN expedition to northern Labrador will take place this summer under the leadership of Professor E. B. Delabarre, of Brown University. It will sail from St. Johns, Newfoundland, about June 24th, and return toward the middle of September. Its aim is the exploration of the coast and interior as thoroughly as the time will allow. One or two scientific men might yet find a place on this expedition; an expert geologist would be particularly welcome. Application should be made at once to Professor Delabarre, 9 Arlington avenue, Providence, R. I.

MISS JOSEPHINE E. TILDEN and Miss Caroline Crosby, of the University of Minnesota, with Mrs. Henry Tilden, of Minneapolis, sailed from Vancouver, May 4th, for Honolulu and the islands of the South Pacific, for the purpose of collecting marine and freshwater algæ.

THE steamship *Windward* has been docked at St. Johns, Newfoundland, and will be thoroughly repaired. It will proceed thence to New York and afterwards to the Arctic regions.

A TELEGRAM has been received at the Harvard College Observatory from its Arequipa Station stating that the position of Eros on April 26, 21 h., 22 m., Greenwich Mean Time, was 15 minutes of arc preceding and 8 minutes south of the position given in the ephemeris by Daniel N. Jones, Jr., published in *Popular Astronomy* (January, 1900), p. 41. This appears to be in response to a letter which was sent to Arequipa on March 12th, asking Dr. Stewart to photograph Eros with the Bruce Telescope, and determine the correction to the above ephemeris.

THE Lick Observatory expedition to observe the total solar eclipse of May 28th, is located a short distance northwest of Thomaston, Ga. Thomaston is a village of about 1800 inhabitants, some 60 miles south of Atlanta. The observers from the Lick Observatory are astronomer W. W. Campbell and assistant as-

tronomer C. D. Perrine. After the instruments are mounted and adjusted, these observers will be joined and assisted by Professor A. A. Nijland, director of the Utrecht Observatory, Dr. J. H. Wilterdink, astronomer in the Leiden Observatory, and by about twelve professional and amateur astronomers from various parts of this country.

THE Western University of Pennsylvania will have an expedition in the field to observe the total eclipse of the sun, which occurs at the end of this month. The expedition will consist of Professor F. L. O. Wadsworth, the director of the Allegheny Observatory; Professor S. M. Kintner, of the Engineering School; Dr. J. A. Brashear, the noted instrument maker of Pittsburgh, and others. Dr. Holland, the Chancellor of the University, may be of the party.

PROFESSOR ORMOND STONE, director of the Leander McCormick Observatory, of the University of Virginia, will occupy a station for the observation of the eclipse, at Winsboro', S. C. His special aim will be to obtain means for studying characteristics of the filamentary structure of the inner corona, which was carefully observed by him, near Denver, during the total eclipse of July 29, 1878. The observations will be both photographical and visual. Dr. William J. Humphreys, of the same university, will occupy a station near the edge of the shadow, in order to study the 'reversing layer.'

THE Russian Government has established a station at Villa Franca, near Nice, for deep-sea explorations. A special yacht for the station has been constructed in Zurich.

THE Botanical Section of the American Association for the Advancement of Science, The Linnean Fern Chapter and The Sullivant Moss Chapter will be the guests of the New York Botanical Garden on Wednesday, June 27th. By invitation the Torrey Botanical Club will present a memorial program in honor of Dr. John Torrey in the lecture hall of the Museum, beginning at 10 a. m. The following features of this program have already been determined: 'Historical Sketch of Botany in New York City,' by Dr. T. F. Allen; 'Personal Reminiscences of Dr. Torrey,' by Professor T. C. Porter; 'Work of Dr. Torrey as a Botanist, with Bibliography,' by Dr. N. L. Britton; exhibition of letters, pictures and material illustrative of Dr. Torrey's work, by Mrs. Elizabeth G. Britton and Miss Anna Murray Vail; work of the Torrey Botanical Club, by the Secretary, Professor Edward S. Burgess. A large amount of interesting historical material has already been sent in response to the inquiry of the Secretary of the Section.

A SUMMER school of natural history has been established by professors of Beloit College on Madeline Island, Lake Superior. Courses in physiography are offered by Professor G. L. Collie; in geology by Professor Grant Smith, and in botany by Professor H. B. Densmore. The location of the school is very favorable for the study of these sciences. The courses will open on July 27th and will continue until August 30th, and the fee for tuition and materials, including the use of a microscope, is only five dollars.

THE international conference for the protection of wild animals in Africa, was opened at the British Foreign Office on April 24th, and was attended by plenipotentiaries of France, Germany, Great Britain, Congo Independent States, Italy, Portugal and Spain. A plan is advocated for the establishment of large reserves like Yellowstone Park, where wild animals may live under natural conditions.

THE need of protecting the larger wild animals is illustrated by a 'Note on the Word Bison,' in the *Bulletin* of the American Museum of Natural History, where Dr. J. A. Allen states that the American bison is practically exterminated in the wild state and its perpetuation depends upon the care and skill exercised to preserve the domesticated herds which, it is estimated, comprise between 300 and 500 individuals. There are possibly 20 bison in the Yellowstone National Park and not a dozen outside of it. About 50 of the Wood bison, the variety found in the vicinity of Great Slave Lake, are believed to be in existence. The paltry numbers given above are all that are left of the millions that once roamed over the west and northwest.

THE American Medical Association will hold its annual meeting this year in Atlantic City, New Jersey, on June 5th, 6th, 7th and 8th.

THE Third International Ornithological Congress will be held at Paris from June 26th to June 30th, as one of the series of meetings to be held in connection with the Paris Exposition. The President of the Congress is Dr. E. Oustalet; the Secretary-Treasurer, M. J. de Claybrooke, and Dr. Alphonse Milne-Edwards who has just died was the Honorary President. The members of the Congress will be the delegates from the French and foreign governments and those who may become members by the payment of a subscription of 20 francs, while zoological and similar societies may be represented by delegates. There are to be five sections as follows: 1. Systematic ornithology, anatomy, paleontology. 2. Geographic distribution, migration. 3. Biology, nidification, oology. 4. Economic ornithology, bird protection, aviculture, acclimatization. 5. Organization of the permanent international ornithological committee. The following is the provisional program under the various sections:

1. Systematic ornithology; classification; descriptions of new genera and species, nomenclature. Anatomy and embryology of birds. Paleontology; classification, descriptions of new genera and species, ancient faunas, relation of extinct to living species.

2. Geographical distribution of birds; existing faunas, species extinct within historic times. Migration. Accidental occurrence of exotic species.

3. Biology; habits, food, nidification, oology.

4. Economic ornithology; protection of useful species, destruction of injurious species, hunting. Acclimatization. Aviculture.

5. Organization and duties of the international ornithological committee. Election of new members.

THE International Anti-Tuberculosis Congress, attended by more than 1000 delegates, was opened in the San Carlo Theatre, Naples, on April 25th, in the presence of King Humbert, Queen Margherita, the Prince and Princess of Naples, and the Duke of Genoa. The delegates present represented the Governments of Germany, Austria-Hungary, France, Spain, Portugal, Sweden and Norway, Greece, Roumania, Russia, and the United States, and included the Duke of Ratibor and Professor Virchow, from Germany, and Dr. Lannelongue from France. The first sitting of the congress was devoted to a discussion of the prophylaxis of tuberculosis.

THE Anatomical Society at Pavia held its annual meeting this year at Pavia from April 18th to the 21st, under the presidency of Professor Gustav Retzius of Stockholm. Among those who contributed papers were Professors Waldeyer, His, von Kölliker, Giacomini, and other well-known anatomists.

THE following announcement has been made by the British Foreign Office: The Secretary of State for Foreign Affairs has received a despatch from Sir H. MacDonell, her Majesty's Minister at Lisbon, containing the following information regarding the facilities which will be granted by the Portuguese government to foreign astronomers visiting Portugal in May next for the purpose of viewing the total eclipse of the sun. A communication has been made to the Lisbon press, stating that, on the occasion of the eclipse of the sun in May, when a number of foreign astronomers are expected to visit Portugal, owing to its favorable geographical position for observation, customs facilities will be granted for the admission of scientific instruments, books, etc., which such visitors may desire to bring with them. Astronomers from abroad will be exempt from payment of the usual custom duties on production at the custom-house, on arrival of a certificate drawn up by the astronomical society to which they may belong, setting forth their names, and describing the instruments and books which are to be imported. This certificate, however, should be legalized by the nearest Portuguese Consulate before starting. Further, it is announced that the Ministry of War has informed the Ministry of Education that all the military authorities of the districts of Vizen, Aveira, Guarda, Castello Branco, and Coimbra will afford any possible assistance to astronomers during the observations, and that tents will be lent to observers, on a request being addressed to the Ministry of War in Lisbon to that effect. A Government notice has now been published in the *Official Gazette*, stating that the King has nominated a Royal Commission for the purpose of assisting

in every way those who may come from abroad for scientific observations, and for superintending arrangements generally. This commission will sit either at the Royal Observatory, Lisbon, or at the Society of Geography, Lisbon; its president is his Excellency Señor Marianno de Carvalho.

UNIVERSITY AND EDUCATIONAL NEWS.

THE Ohio Legislature with only three dissenting votes has placed a special tax on property for two years of one-twentieth of a mill on the taxable property of the State for the Ohio State University. This will yield $90,000 a year, which will provide a building for the department of physics and one for the college of law.

IT is reported in the daily papers that the Rev. F. H. James of Oakley, Kans., having inherited a large sum of money, will endow a Methodist University in Kansas City with $1,000,000. It is also stated that he has also given $300,000 for a college in Oakley. It is to be hoped that these reports are correct.

THE University of Wales has received a bequest of £5500 for the foundation of scholarships from the late Mr. Price Davies.

THE summer school in practical mining of Columbia University will be conducted by Professor Robert Peele at Cripple Creek, Colo. After five weeks spent in the mines the student will have two weeks work in geology with Professor Arthur Hollick.

Nature states that the report of the Advisory Committee appointed to inquire into the best manner for providing for scientific and commercial training respectively in connection with the new University of Birmingham has just been issued. It will be remembered that Mr. Andrew Carnegie and an anonymous donor each promised a gift of 50,000*l.* toward the establishment of these two departments. The committee have made inquiries as to facilities for the teaching of science in its application to industries, and they report that, in their opinion, no such teaching, complete as they contemplate it, and as it must be, if it is to be successful, exists in any college in Great Britain. In making their recommendations, the committee have had in view the object of the teaching of science in its application to industry, coupled with such technical instruction in handicrafts as will enable the students to complete their course in the University itself. It is proposed that the facilities already provided in Mason University College should be supplemented by chairs of mining, metallurgy, engineering, and applied chemistry. The scheme submitted contemplates the introduction of a complete equipment for the treatment of metals by heat and a small plant for treatment by electricity, as well as the necessary outfit for testing metals. Shops would be provided for manual training, and it is recommended that the machines used should be of the best and most modern type of English, American, and foreign manufacture. The committee further recommend the acquisition of 25 acres of land in the outskirts of Birmingham on which to build the University, their estimate of the total cost being 155,000*l.*

PROFESSOR C. S. PROSSER has been made acting head of the Department of Geology in Ohio State University.

THE following fellows have been appointed at the University of Pennsylvania: Zoology, J. R. Murlin and Miss R. A. Vivian; pedagogy, I. B. McNeal; mathematics, U. S. Hanna; biology, Miss C. B. Thompson; sociology, Miss C. Kimball.

PROFESSOR LUDWIG BOLTZMANN, of Vienna, has accepted the call to the chair of physics in the University of Leipzig.

M. MOISSAN has been appointed professor of inorganic chemistry in the Paris School of Pharmacology in the place of M. Riche who has retired.

MR. J. F. HUDSON, of Oxford University, has been appointed mathematical lecturer at University College, Bristol, in succession to Mr. J. F. McKean who has been appointed a mathematical lecturer at the Royal Naval Engineering College, Devonport.

DR. MEYER has qualified as docent in physics in the University of Vienna, and Dr. Oppenheim as docent in theoretical physics in the German University of Prague.